AGRICULTURAL ENGINEERING

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Engineering Phases of Land-Use Planning[1]

By S. H. McCrory[2]

AGRICULTURAL SURPLUSES and the agricultural depression have emphasized the importance of considering carefully our land problems. The planned use of land has been suggested as one of the integral parts of a program leading to a more successful and profitable agriculture. National planning is now being considered along three broad lines: Physical, economic, and social. One does not go far in the consideration of any of the planning undertakings before it becomes apparent that the three phases are so closely intermingled that they can be separated only with difficulty. In such undertakings there is need for a critical examination of the proposals and their probable consequences by technologists with a broad knowledge of agriculture.

Until very recently the policy of the United States has been to transfer the title to land to private individuals as rapidly as possible without regard to its future use. Under this plan the nation has grown from the few small struggling colonies to a nation of over 125 million people in the last three centuries. By 1915 our resources of land which could be cheaply and quickly developed had been exhausted. The remaining undeveloped public domain suffered from some disability which either could not be corrected or could only be corrected by considerable expenditures. In the first class might be mentioned land in the semi-arid region not within the scope of an irrigation project; in the latter class, lands requiring heavy expenditures for irrigation, drainage, flood protection, or landclearing. Under this policy we have also developed a number of areas in which farming has been more or less precarious and where the development of a profitable agriculture presents difficult aspects.

About 1920 the problem of agricultural surpluses began to develop difficulties, and it was apparent that the world's agricultural and industrial production which had been expanded to meet war conditions was operating at too rapid a rate for the post-war period. Nations moved to meet the situation. World trade barriers, both industrial and agricultural, began to be erected, and as they were developed, they have intensified the agricultural depression by stimulating home production and reducing imports. Taxes absorbed an increasing proportion of the national income as prices lowered and incomes decreased. The depression brought to the fore the question of what was the most beneficial and most efficient use which could be made of the lands of a given region and how such use could be most readily brought about. Many agencies have been interested in the different phases of this problem. One form of land planning which has for some years past been actively carried forward is the city or metropolitan regional planning. Typical examples of such planning have been those for the regions of New York, Chicago, and Washington. The areas have been classified into different zones by ordinance and their use restricted. Such plans have been most helpful in directing the growth of the areas along proper lines and preventing unfortunate developments.

Another type of study which may have a profound influence on the development of a region has been the state or regional highway traffic surveys which have been made by the state highway departments and the U. S. Bureau of Public Roads to afford a basis for planning a highway system to serve a state or a region.

Recently many states which have been troubled with the problem of what to do with lands which could not be cultivated profitably, have, through various state agencies, been engaged in making studies or surveys to determine what conditions existed and the proper solutions. Outstanding work along this line has been done in Michigan and Wisconsin. Various studies have been made by the U. S. Department of Agriculture and the state agricultural experiment stations. In November 1931, Secretary of Agriculture Arthur M. Hyde, in cooperation with the Land Grant College Association, organized the National Land-Use Planning Committee consisting of representatives from the Land Grant College Association and various governmental services, and for about two years this group made an intensive study of the problem and did much to stimulate and clarify thinking toward its solution. Recently many new agencies have begun to study the problems of land planning. Among the new and old agencies working in this field may be mentioned the following:

- National Planning Board
  - Frederic A. Delano, chairman
  - Wesley C. Mitchell, National Bureau of Economic Research
  - Charles E. Merriam, professor of political science, University of Chicago
  - Charles W. Eliot, II, executive officer
- Federal Emergency Relief Administration
  - Harry L. Hopkins, administrator
- Federal Surplus Relief Corporation
  - Harry L. Hopkins, president
- Tennessee Valley Authority
  - Arthur E. Morgan, chairman
- Reconstruction Finance Corporation
  - George R. Cooksey, secretary
- Farm Credit Administration
  - W. I. Myers, governor
- Science Advisory Board
  - Karl T. Compton, chairman
- Emergency Conservation Work
  - Robert Fechner, director
- U. S. Department of the Interior
  - Subsistence Homesteads, M. L. Wilson, director
  - Soil Erosion Service, H. H. Bennett, director
  - General Land Office, Fred W. Johnson, commissioner
  - Bureau of Indian Affairs, John Collier, commissioner
  - Geological Survey, W. C. Mendenhall, director
  - Bureau of Reclamation, Elwood Mead, commissioner
  - National Park Service, A. B. Cammerer, director

[1]Symposium of papers presented at the 28th annual meeting of the American Society of Agricultural Engineers, at Detroit, Michigan, June 1934.

[2]Chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

Bureau of Mines, Scott Turner, director
U. S. Department of Agriculture
Agricultural Adjustment Administration, Chester C. Davis, administrator
Bureau of Plant Industry, Knowles A. Ryerson, chief
Forest Service, F. A. Silcox, chief
Bureau of Chemistry and Soils, Henry G. Knight, chief
Bureau of Biological Survey, Jay N. Darling, chief
Bureau of Public Roads, Thomas H. MacDonald, chief
Bureau of Agricultural Engineering, S. H. McCrory, chief
Bureau of Agricultural Economics, Nils A. Olson, chief
U. S. Department of Commerce
Bureau of the Census, William L. Austin, director
U. S. Department of War
Office of the Chief of Engineers,
Maj. Gen. Edward M. Markham, chief
U. S. Department of Labor

The National Planning Board has stimulated the appointment of state planning boards and has provided technical assistance for these groups. Some forty state planning boards are now actively at work and serve as a clearing house and coordinating agency for all types of planning activities.

Many things may cause land to be temporarily or permanently not suited to the type of use to which it is being put, or to its profitable utilization for agricultural purposes. Among these are topography, character of the soil, rainfall, stumps, soil erosion, poor drainage, competition from other regions which have more favorable conditions, farms of uneconomic size, widespread tax delinquencies, poor tenant systems, and lack of proper credit facilities.

Planning the Best Use of Land May Become a National Necessity

Whatever the cause, we face as a nation the problem of deciding how many millions of acres may be administered so as to most efficiently promote the best interests of the nation. Heretofore our lands have been developed helter-skelter with regard only for today. It is my conviction that the time has come when as a nation we should plan the use to which our lands are to be put. The first step in this undertaking should be the determination of our needs as a nation, over a considerable period of time, for the products of agriculture and forestry. For example, our probable requirements for cereals, livestock products, fibers, and wood products should be forecast as accurately as practicable. Second, there should be a classification of the land. After our needs have been determined and facts in regard to the physical condition of the land are available, there should be a careful study of the physical, social, and economic factors to determine the types of agriculture and industry which can be followed most profitably in each region. After this has been arrived at will come the problem of working out the most advantageous use of the land in the region. Some lands are clearly suited to agriculture; some to forestry; some may be especially adapted to other purposes, while other lands are suited for grazing only. There will, however, be large areas of land which can be used for various purposes and a determination of its best use will require careful study by careful technologists.

It seems certain that there should be a great increase in the area devoted to state and national forests. Evidence contained in the Copeland report, which was submitted to Congress last year in regard to this, is most convincing. It will also undoubtedly be advisable to place the unforested public domain under regulation for the purpose of conserving vegetative cover and the soil. Experience on controlled areas has shown that after run-down lands have been properly restored they are much more productive than when they are in their overgrazed condition.

"IN ARRIVING AT A DECISION IN REGARD TO ANY AREA," SAYS MR. MCCRORY, "ATTENTION SHOULD BE GIVEN TO THE ENGINEERING PHASES (OF LAND USE PLANNING) WHICH IN MANY INSTANCES MAY BE THE CONTROLLING FACTOR IN DECIDING THE USE TO BE MADE OF A GIVEN TRACT"

If one may judge from present conditions, it will be advisable to augment the public domain by the purchase of lands which experience has indicated are unsuited for farming. There is need also for additional areas for parks, public shooting grounds, wild life refuges, and similar purposes. For these purposes lands of types not suited for agriculture are usually satisfactory. There will remain, after we have allotted the land, the use of which under present conditions is definitely apparent, a large area the best use of which is not readily apparent and can be determined only after careful investigation of all factors affecting such use.

In arriving at a decision in regard to any region, attention should be given to the engineering phases which in many instances may be the controlling factor in deciding the use to be made of a given tract. To the engineer should be given the task of determining the lay-out of the region. He should decide upon the location and types of roads, water supply, power lines, telephone lines, drainage and irrigation ditches, and to him should be entrusted the clearing of the land and the control of erosion and provision for erosion control where necessary, the kinds of machinery to be used, and the types of housing with the layout of farms and farmsteads. Supervision of the construction of these improvements should obviously be under proper engineering direction. In this undertaking the engineer should collaborate with technologists in other fields in developing the best possible pattern for the undertaking. No engineering lay-out which is based on physical facts alone can hope to be successful. To any land planning, if it is to succeed, there must be full and close cooperation between the technologic, economic, and social groups. Undoubtedly the making over of a region is a much more complex problem than the settling of a new region, for in a developed community we have towns, villages, farms, railroads, highways, telephone lines, power lines, in fact services of every character which have been established and in which someone has certain rights. It will require the utmost care to see that justice is done to all and that the most equitable solution possible of all the technologic, economic, and social problems is arrived at. In land planning operations I believe that engineers as a group have a most unusual opportunity to make a significant contribution, and they should insist upon being given the chance to develop their field in the same way as the social and economic fields are being developed. In

some undertakings there has been a tendency for the social or economic groups to attempt to direct the entire project and, when in their judgment they were needed, to use engineers as service men, not as technical advisers. If land planning undertakings are to succeed, it is essential that there be a head to the project who will give each group an opportunity to make its proper contribution to the success of the undertaking. Only if such a set-up to handle the economic, social, and engineering problems is arranged can the project hope to reach its highest success. Agricultural engineers by training and experience are exceptionally well qualified for this type of work. How may they most quickly assume their rightful place in such undertakings and make their maximum contribution to the success of the enterprise?

Discussion by Leonard J. Fletcher[2]

The Mechanization Phase

LAND-USE PLANNING, in a broad sense, includes making provision for every activity or influence which has any connection with the use of land for agriculture, forests, recreation, storage of water, etc.

Efficient land utilization for agriculture may be defined as land used to produce crops for which it is best suited, in such sized units and employing such methods as will return the maximum net profit to the individual farmer operator without decreasing the productive capacity of the soil. It is therefore evident that, taken by themselves, production per acre, production per man, the ratio of self-sufficiency, or maintenance of soil fertility are not true gages by which to measure the efficiency of land use.

Ask the farmer or scientific agricultural worker of the past decades: "What is efficient use of land?" He would likely reply: "Maximum production—either per acre or per hour of labor expended."

In the past we have largely thought of land in terms of production. When we talked of the "worn-out farm problem," we visualized a farmer moving westward to new land and starting over.

Today the picture is changed. The job of farming, the job of the agricultural scientist—in fact, one of the major jobs of our government—is to consider land use from two viewpoints, namely, production and maintenance.

We have reached a period where we must earnestly consider the maintaining of our farms in a manner that will insure continuous productive capacity for the generations to come.

Peoples of other countries have followed their soil from the uplands to the valleys and deltas, where they carry on a more or less crowded existence fighting flood, famine, and disease. This country is showing its wisdom and ability by recognizing this problem before it has driven us into this position. It seems to be a question now before the country, as to whether private ownership can be trusted with the dual responsibility of maintaining our most valuable resource—the land—as well as utilizing it for maximum production. Here is a real challenge! There is without doubt the proper place for federal aid and direction, and the proper place for private enterprise.

Mechanization has a great place to play in this program. Where we have planned our power and machinery programs on the basis of production of crops, we now must plan these programs on the basis of both the maintenance of the farm and the production of crops. In fact, in some areas and for some years to come, there is not only a maintenance job, but also a major repairing task. The soil has been lost at a much higher rate than it has been formed. Good soil has been washed away; gullies have formed. In those areas the power demand per acre will materially increase until provision is made for holding soil. Only after soil is kept in place can a soil improvement program be undertaken.

Backward-Looking Thinkers Attract First Attention in an Economic Crisis

This job of maintenance, added to the job of production, will result in an increased power demand. There will be an increase in the present altogether too small farm power load factor; there will be more use for existing farm power and machines, and some new demands to be met by machines especially designed for the purpose. The whole job of farm mechanization must be reanalyzed to determine where this added load of farm maintenance and repair affects the design or use of our present-day farm equipment.

In every economic crisis it appears that the group of thinkers whose words first attract attention are those who are looking backwards. Later more sound judgment prevails; calm and intelligent analysis produces the thoughts, information, and advice which finally sets the whole nation along its forward progress once more. A nation which has once experienced the benefits from the harnessing of mechanical energy to the carrying out of their everyday tasks, will never willingly go back to hand labor.

We can well afford to read carefully the statements of Dr. O. E. Baker. In his treatise, entitled "Recent Social Trends in the United States," he states (Chapter 2): "The outlook for land utilization in the United States is, briefly, toward an increase of crop acreage, mostly at the expense of pasture, in the more level or fertile areas, where tractors and associated machinery and the increasing use of fertilizer are likely to lower still further the cost of crop production relative to the cost in the less level or less fertile areas. In many of these fertile or level areas most of the crops are sold rather than fed (the cotton belt, wheat regions, central Illinois section of the corn belt, and other areas). Here the trend doubtless will continue to be toward larger farms. Continued progress in animal

[2]Agricultural engineer, Caterpillar Tractor Company. Mem. A.S.A.E.

"IF WE ARE GOING TO MEET THE PRESENT WORLD COMPETITION IN PRODUCTIVE EFFICIENCY," SAYS MR. FLETCHER, "WE MUST CONTINUE TO DO A BETTER JOB OF PUTTING, NOT AN ENGINE ON THE SCYTHE, BUT A SCYTHE ON THE ENGINE"

husbandry and use of fertilizer on pastures will tend, likewise, to concentrate production of animal products on the better land. Livestock farms, however, may not increase in area, but will tend to increase in productive capital. Near the large cities, and elsewhere in localities having exceptional transportation or marketing facilities for perishable products or possessing peculiar advantages of climate, agricultural production is likely to become still more intense and lead to the establishment of many small farms. In other words, production will tend to concentrate on the more level, more fertile, or more favorably located lands, and these will be cultivated more intensively, not necessarily by more labor but mostly by the use of more capital. . . . .Of these things we may be sure: That the soil resources are being depleted and often wasted; that there will be further progress in agricultural technique; that there will be notable regional and local shifts in production; that a decreasing proportion of the population engaged in full-time farming will be able to produce plenty for everyone in the nation to eat; that both public and private action will be necessary to solve the vast problems of land utilization; and that the family farm and individual initiative will remain characteristic features of American agriculture."

Dr. B. H. Hibbard, in his recent paper on "National Agricultural Policies," states: . . . . . "We need more national forests, more free grounds, more erosion control, more material and spiritual reward for the people that provide us with the materials out of which we fabricate our food and clothing. . . . .Prosperity must come ultimately from production—not from destruction and inaction."

Any Land-Use Plan Must Consider Factors of Most Efficient Production

Any land-use plan to correctly meet the conditions of world competition ahead must consider those factors which will enable the most efficient agricultural production on the basis of any certain farming area considered as a whole. There is no necessary conflict between the individual family farm, as the most desirable social organization, and efficient production designed to take advantage of any present or future mechanical development adapted for use under the general farming conditions prevailing in any locality. In other words, from the standpoint of farm mechanization, the fence line must not be a barrier. The agricultural engineers today are being asked to put an engine on the scythe. If we are going to meet the present world competition in productive efficiency, we must continue to do a better job of putting scythes on the engine.

The wheat farmer of the Plains area, who yesterday was criticized for expecting to make a living with the expenditure of but a few months of work in the planting and harvesting of his crop, could today be held up as a model of productive efficiency.

Mechanization in the production of farm crops, as well as in the maintaining of our farm lands, is, first of all, a liberator. The real product of farm mechanization is leisure. We have eliminated the fear of famine and hunger. Mechanization has drawn a new picture of farm life, changing it from one of excessive human toil and hardship to one of joy in the privileges of rural life. A principal task of those concerned with rural matters in the United States is that of learning how to develop and coordinate the beneficial results of mechanization rather than condemning and attempting to destroy them.

Discussion by Harper Sibley[4]

Planning for Balanced Economy

DURING the past several years the farmers of the United States have been greatly disturbed by surpluses in many agricultural products. These surpluses have arisen from a total production which, temporarily at least, has exceeded current consumption. One of the elements of planning is to eliminate these surpluses and to adjust production to available demand.

In planning for the use of the land areas of the United States, these surpluses come from the productive, fertile areas primarily, rather than from the poorer, marginal areas. Therefore, any program of planning must certainly include the fertile farm areas of the country as well as the marginal areas.

I am highly in sympathy, of course, with any program to put the land areas of the United States to their most desirable uses. In the past there has been practically no planning and the people of the United States settled down without any supervision as to the lands they were occupying. As a result, tens of thousands of farm families are to be found in various parts of the United States on land where they ought not to be—in areas that are not economic and do not provide an adequate standard of living.

A matter of first importance, therefore, is the problem of human engineering in regard to these families.

Of course, I do not undervalue the need of planning for the use of the land itself, especially from the point of view of conservation. Vast surfaces of the United States have lost their fertility, or are losing it, due to the cutting down of the forests, to the plowing up of virgin sod, and to the continuous plowing of the land. The losses due to erosion, both from water and wind, are growing serious primarily in the marginal areas, but to a serious extent in the fertile areas as well. Not only is the land becoming sterile, but floods and overflowing endanger fertile valleys and watercourses.

There are three definite steps which should be undertaken, all of which require the highest engineering skill.

First of all, we should complete the classification of the land surfaces of the United States, both from the physical and from the economic point of view. These studies will determine which areas are suitable for human settlement and what types of agriculture should be chosen for the area.

Second, when the classification is completed, long-time plans should be prepared as to the best use of each classification so that the soil fertility of the United States may be preserved for future generations. Large parts of the marginal lands will be suited to reforestation; other areas should be protected to provide the best possible grazing; still others will be zoned for the preservation of wild life and for recreational purposes. But more important even than providing a proper plan for these marginal areas is the development of a plan for the fertile areas, for those lands in the highest classification. If these lands are allowed to deteriorate through poor systems of cropping, through erosion, and other wasteful practices, then the food supplies of the future may indeed be in jeopardy.

Moreover, in any program to balance the production of agricultural crops with current demand, through adjustment either for reduction or increase, these fertile lands must primarily be taken into account, for after all a relatively small proportion of our national supply of foodstuffs

[4]Part owner and manager, Sibley Farms. Mem. A.S.A.E.

comes from the marginal areas. If it is overproduction. it is the overproduction of the great plains and the fertile valleys.

And thirdly, having classified our land surfaces and having laid out a long-time program for their use, we must then consider those emergency measures which may be needed to meet temporary depressions. Whether these emergency measures should properly include cooperative plans for adjusting acreage, for reducing or increasing the number of livestock to be bred, and for restricting the sale of products beyond the stipulated total, are matters of extreme importance.

Further, whether the governments shall extend short-time and long-time credit on agricultural lands and shall participate when necessary in problems of relief due to drought or flood, is also of great importance.

There seems to be a definite feeling, at least on the part of many of the farm leaders, that unrestricted individualism in agriculture can no longer be maintained. These men believe that intelligent planning is essential to a balanced economy. Certainly such planning is absolutely impossible without the full and earnest cooperation of agricultural engineering.

Discussion by E. R. Jones[5]

The Land Reclamation Phase

ONLY A DECADE AGO, land reclamation was synonymous with agricultural expansion. "Food will win the war" and "Two blades of grass where one grew before" were on every tongue. He who heeded not was a slacker.

Today it is "Reclamation for recovery." Not for the recovery of more acres for agriculture, not for expansion, but for adjustment. Not for more acres, but for more profitable, home-affording farms. Not more corn fields—and probably not any fewer—but, regardless of the number, better corn fields.

[5]Professor of agricultural engineering, and head of the department, University of Wisconsin. Mem. A.S.A.E.

TODAY THE KEYNOTE IS "RECLAMATION FOR RECOVERY"—NOT FOR THE RECOVERY OF MORE ACRES FOR AGRICULTURE, NOT FOR EXPANSION, BUT FOR ADJUSTMENT. "BUILDING TERRACES AND SOIL-SAVING DAMS, PLACING FENCES ON THE CONTOUR SO THAT CONTOUR CULTIVATION IS POSSIBLE, FENCING THE GULLIES WHERE HEADS HAVE BEEN STOPPED," SAYS MR. JONES, "ALL MAKE FOR BETTER FARMING, WHICH, AFTER ALL, IS THE KEY TO RECOVERY"

Now let us see how land drainage, land clearing, soil erosion control, irrigation, retirement of submarginal lands, and zoning of land on the basis of use, fits into this 1934 definition of land reclamation.

Last week, the county agricultural agent of Richland County (Wisconsin) wrote me for help in starting a project for dredging and straightening Pine River for a distance of 15 miles. It didn't take long to give him the right answer. It was this: "Don't dredge the river."

I know that this county agent is under pressure. His farmers, after four dry years, have forgotten the floods of ten years ago. All they can picture is a corn field on the bottom land, while the hillsides are parched and dry. Next year we may have two or three June floods to cover the valley bottom with four feet of water, and all the farmers will have will be regrets for having spent, or promised to spend, 20 dollars an acre for the channel improvement.

There Is a Place for Every Phase of Reclamation in Land-Use Planning

That land needs dredging, diking, pumping, tiling, and land clearing to make it safe for cultivation. It could never bear that heavy investment. Better seed it to grass for permanent pasture or hay land without further improvement. Or fence the timber for a permanent woodlot.

But there is a kind of drainage that does pay. John Wutz had a 160-acre farm including 30 acres of marsh above the flood plain of the river. The rest was rough pastured woodlot and small hillside fields. He had ten cows, fair buildings, and a mortgage of $6,000 on the farm. I persuaded the mortgagee to loan him $1,500 more to tile 15 acres of the marsh for a corn field, to build a silo, and to get more cows. Today John has the whole 30 acres tiled for cultivated crops, alfalfa seeded on his sidehills, the woodlot fenced to give the forest a chance, and has whittled the debt down to less than $2,000. He isn't complaining about the depression.

Likewise farmers who are tiling wet strips in cultivated fields are surviving.

In the Coon Valley Project of the U. S. D. I. Soil Erosion Service, I have advised tiling one acre of bottom land for every five acres of steep sidehill retired from cultivation. This tiling is at government expense, and it is good business for both the government and the farmer

In the field of irrigation, let us discontinue the policy of opening up new districts or projects; frankly abandon some of the sparsely settled districts; but intensify the irrigation practice in those districts that now are farmed to the extent of fifty percent or more. Yes, and here in the North Central states, don't forget that potatoes, small fruits, and truck crops respond to water pumped from lakes, rivers, or deep wells. The time is not far distant when laws will be liberalized for using public waters for private irrigation.

I am just as willing to admit that some of our partially drained marshes should be assigned to some use other than agriculture. Put dams in the ditches for fire protection and growth of vegetative cover, and feed for birds and game in a publicly owned game preserve or shooting ground. Withdraw the scattered settlers from cut-over lands, and reserve land clearing for the zones in which agriculture is permitted.

After having spent the major part of my energy for the past fifteen months directing the soil erosion control

work in Wisconsin CCC camps, I have a wholesome respect for the place of that work in the recovery program. Building terraces and soil-saving dams, placing fences on the contour so that contour cultivation is possible, fencing the gullies whose heads have been stopped—all make for better farming which, after all, is the key to recovery.

No better proof of the economic wisdom of land reclamation is needed than the fact that the Northwestern Mutual Life Insurance Company of Milwaukee has in the last two years put on four agricultural engineers to plan and execute improvements on the more than 700 farms now owned by that company. They move fences, drain wet strips, shoot the tramp stumps, remodel buildings, and improve the landscape. They find that $800, as an average, spent on the improvement of a farm makes an attractive farm out of what wasn't much of a farm before. Maybe it's farm management; maybe it's landscape architecture; maybe it's forestry; but I notice that it's an agricultural engineer that they get to do the job.

Discussion by R. H. Driftmier*

The Structures Phase

THE PLACE of farm structures in a land-use program is not an exclusive engineering problem. Good engineering can provide adequate structures, safe water systems, modern plumbing, and up-to-date heating plants. These should all be provided, for it would be a social and economic waste to build homes or service structures that are not safe, sanitary, and well designed. These buildings must form a part of a modern community and as such satisfy the educational, social, spiritual, and economic aspirations of that community. Cooperative study is required in order that the problems involved may be properly analyzed and a practical plan for their solution evolved.

Just recently such a coöperative effort has been carried out. I refer to the National Farm Home Survey conducted by federal and state agencies. This survey has been a wonderfully fine piece of work. It has done much to help the engineer, the home economist, the agriculturalist, and the social worker to get oriented.

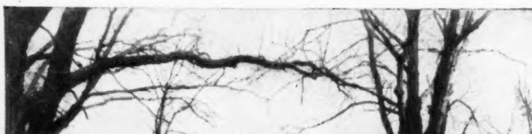
This survey has indicated one very gratifying thing, and that is that people really want to improve their homes and their surroundings. It is to be hoped that some method can be worked out whereby alterations, modernization, and repairs can be made even before new construction is done.

Farm structures can be divided into two general groups: those on the individual farm and those that serve the community for educational, recreational, or processing purposes. The situation in which we find ourselves at the present time is not an easy one, yet certain fundamental principles, if observed, will adequately safeguard future building programs. Our building operations must have some degree of balance. There must be a safe margin of production or anticipated returns to building values to prevent top-heavy or unsound investments.

Agriculture is not only a business for commerce, but also one of subsistence. There is no necessity for the subsistence feature, unless we have the commercial feature in light of what the family will do on the farm. Accordingly farm structures must be planned to stand the test of this principle, to fit into the farm organization and serve a definite utilitarian purpose depending on the farming operations practiced. The agricultural engineer must be fully informed as to the agricultural trends of his region. This is increasingly important as lands are being classified and zoned into definite areas for production.

The second general principle to which our building program should be subjected is one of liquidation and use. Farm buildings cannot be liquidated except through use. Like a human being, every building has a life span which can be determined with reasonable accuracy. Its value as a residential structure, as a service building, or as a processing plant depreciates with age. If economic conditions were static or if they changed only slowly, then long-time programs of production or processing could be projected. However, abnormal developments in science and agriculture create abnormal obsolescence that cannot be definitely measured. The farmer cannot judge the trends of supply and demand nor the effect that changing conditions may have on future returns. The economic value of the building will be affected by these conditions which are not attached to the building itself. Accordingly it will be necessary to determine the types of buildings and methods of construction that will not only adapt themselves to a changing agriculture, but will also have use and so yield returns throughout the life span of the building. This suggests unit construction and dual-purpose buildings—structures that can be added to or converted at a minimum cost. As the farming business expands more structures are required, and as agriculture changes the buildings must be adapted to fit into the new organization.

In those regions where small farms prevail, there will undoubtedly be required community processing plants, market centers, and recreational and educational structures. These require very careful consideration and planning, since they affect an entire community rather than an individual. In Georgia a community processing plant has been developed. The plan is adaptable and can be built in units. For example, a community canning plant may serve as the nucleus and is one wing of the future plant. The central wing may serve as a market, as a meat-curing plant, as a warehouse, etc. The companion wing to the cannery may serve as a creamery, or any of the above-mentioned purposes. Such a structure it is hoped will grow with the community and can be adapted to meet changing conditions and agricultural practices. This same procedure should, I think, be followed for all buildings.



"THE FORM WHICH FARM BUILDINGS TAKE," SAYS MR. DRIFTMIER, "IS NOT SO IMPORTANT AS THAT THESE BUILDINGS MEET DEFINITE NEEDS, ARE USEFUL AND CAN BE LIQUIDATED"

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"CERTAINLY NO LAND-UTILIZATION PROGRAM CAN BE COMPLETED WITHOUT TAKING INTO ACCOUNT THE CHANGES WHICH THE USE OF ELECTRICITY IS DAILY BRINGING ABOUT IN OUR SOCIAL AND ECONOMIC SYSTEM," SAYS DR. WHITE. "IT REMOVES THE GREAT BARRIER—LACK OF CONVENIENCE—FROM LIVING IN THE COUNTRY"

The third test to which our building program should be subjected is one of capital investment. The greater the advantages of location, the greater capital investment is justified. Further, that structure that serves the farm most in way of returns will also justify a greater investment. However, there must be a balance between investment in buildings and returns from the livestock or processing cared for. It seems reasonable that the farm home can justify greater expenditure than the city home for like net incomes, since the rural home serves as the administrative center as well as the dwelling of the family. The form our buildings take, as far as materials used are concerned, is not so important as that these buildings meet definite needs, are useful, and can be liquidated.

Discussion by E. A. White[7]

The Electrification Phase

WHATEVER MAY BE the grand scheme of Nature regarding the use of land, as far as man is concerned it relates primarily—in fact, one might say exclusively—to its contribution to the enhancement of the economic and social wellbeing of the human race.

From my standpoint, the engineer believes in an economy of plenty, not only plenty of the necessities of life—food, clothing, and shelter—but also plenty of the materials from which luxuries are produced. We propose to smite the earth and make its blessings gush forth in abundance. Furthermore, we offer a philosophy to society which proposes to do this with a minimum of man-hours. We prefer to have this smiting done by the pushing of a button or the turning of a switch. Probably in the ideal engineered society even this turning of the switch would be performed automatically.

A little thought will quickly lead to the recognition that land provides other requirements than materials from which necessities and luxuries are made. It furnishes the foundations for dwellings, commercial buildings, towns and cities, electric transmission lines, transportation and communication systems. Even air rests upon soil. This same land absorbs energy from the sun; furnishes food for plants, and, indirectly, for animals; receives and stores moisture, and performs many other functions some of which may be yet unknown to us.

Numerous of these functions of land are of course beyond man's control, and will not be discussed here. When we come to consider those things more or less under our control, it should be evident that primary consideration, especially from an agricultural standpoint, should be given to our productive lands. What should man propose to do with those lands which, when smitten, gush forth in abundance? This, as I conceive it, is the hub—the essence—of any land-use policy. After this has been threshed out, next in order will come those lands on the borderline which, by some means or other, are worth saving, and then, if time, energy, and resources remain, attention agriculturally may be given to distinctly marginal or submarginal lands. Many of the areas distinctly submarginal from an agricultural standpoint have economic or social value for the growing of timber, raising of game, and furnishing recreation. These phases of the problem deserve more attention than can be accorded to them in this paper. True, such a policy would reverse much of the land-use work already done, and, I believe, greatly to man's advantage.

Electricity an Important Factor in Any Land-Utilization Program

The amount of attention given to land-use planning today would indicate that either we are woefully short of something else to do, or our present land-use policies are unsatisfactory. The latter is assumed to be the case. Therefore, we should do something different, but yet not fundamentally different, for just as the pioneers took conditions as they found them, leaving us a land-use policy, so it is our opportunity to couple the accumulated wisdom of the ages with what vision, initiative, and industry we may possess to make our land-use policy. We have greater opportunities than they because of the fruits of their labors.

As I see the situation, electricity will be an important factor in at least four phases of our future land-utilization program:

1 Improving the standard of living of farmers

2 Making it desirable for more urban workers to live in the country

3 Reducing the man-hours necessary for production, thereby making more leisure time available

4 Decentralization of industry

Phase No. 1. This can be quickly disposed of. It is universally recognized that through the use of electrically operated equipment a farm home with electric service available can be made just as modern as any other home, anywhere. You don't have to move to town any more to obtain modern conveniences. Therefore, one urge to drain the country of its population has been removed. More attention will be paid to improving the farm residence and less to accumulating a surplus with which to move to town.

Phase No. 2. This living convenience factor, coupled with other developments, makes it possible and in many cases desirable for urban workers and business people to live in the country. Today you do not have to farm to be a rural resident. The home in the country is a luxury which can be enjoyed three hundred and sixty-five days in the year. This movement of population will of course take land out of production for homesites, roads, etc. It promises to be more pronounced in the future than has been the case to date.

[7]Director, Committee on the Relation of Electricity to Agriculture. Charter A.S.A.E.

There is one phase of this problem, however, which calls for engineering attention. The idea of such rural residents producing a considerable part of their own food supply is being urgently pressed in certain quarters. Under present conditions, with the small units of production, this means an increase in man-hours—a reversion to the spade and the hoe. Now there is certainly no objection to a man digging in the ground or hand-tending plants and vegetables from a recreation standpoint. We have nothing to say to the man who enjoys such work, but as engineers we do have serious objections to any social system, no matter by whom promulgated, which consigns man to use his body as a prime mover. From our viewpoint it is a step backward socially. It is uneconomical. If the small garden is to become a national rural institution, we must find some way of introducing the mechanical motor.

Phase No. 3. The engineer has not yet finished with reducing the man-hours required to produce the necessities and luxuries which man demands and desires. Furthermore, he is in no humor to take an extended vacation either. The sooner this is universally recognized, the sooner will we arrive at a workable land-utilization policy. Of course, electricity will play an important part here, especially in operations adapted to the use of a stationary prime mover. This means more individual leisure, which should be most profitably used by country residents even though a goodly portion of it may be spent in town.

The Agricultural Engineer Urges Attention to Recreational Considerations

While the recreational advantages of urban centers are recognized, the engineer believes this problem should have an important place in any sound land-use program. Ample provision should be made for golf links, tennis courts, baseball diamonds, forest preserves, fishing grounds, game preserves, wild life refuges, and hunting areas. We believe in play and recreation just as ardently as we believe in reducing man-hours in production enterprises.

Phase No. 4. Much has been said and written about decentralization of industry, yet it is a most difficult subject upon which to become oriented. However, with our ability through the use of electricity to have as much energy as is required, where it is wanted and when it is wanted, at reasonable cost, another great barrier to decentralizing has been removed. Looking at this problem in perspective, it would appear logical for new industries and many old ones to locate factories, especially for the processing of agricultural products, closer to the source of raw materials.

Many alluring pictures have been presented of the combining of agricultural and industrial operations. To date the results in this direction have been negligible. The individual apparently desires to be either a farmer or a factory worker. However, I do believe that in many regions we will have industrial developments, large and small, introduced to the mutual benefit of all concerned. This, of course, will require land for residences, business and factory sites, and take or keep an increasing number of people in rural districts.

Certainly no land-utilization program can be complete without taking into account the changes which the use of electricity is daily bringing about in our social and economic system. It removes the great barrier—lack of convenience—from living in the country, and from a power standpoint makes possible the decentralization of industry which in turn calls for a decentralization of population

Discussion by D. Howard Doane[8] and C. H. Everett[9]

The Management Phase

WE HAVE become land-use planning conscious so recently that we are still in the stage of aims and objectives. We are getting our first experience in methods and procedure in the work of the Agricultural Adjustment Administration and related activities.

A decade of struggling with the disparity between farm income and other incomes, climaxed with a complete collapse in farm prices, has caused us to wonder if we might not be better off under a system of planned production for the agricultural industry as a whole. Along with this we have begun to realize that to properly preserve our agricultural resources, there should be some concerted efforts toward concentrating production of various crops on lands best suited to their production, eliminating the production of those crops which are ill-adapted to the lands on which they are being produced, and retiring from use such lands as are considered incapable of supporting profitable production.

Land-use planning, considering it broadly, is based on two premises: First, that the amounts of various agricultural commodities needed commercially may be fairly accurately calculated from the number of consumers possible of reach through available markets and the extent of their ability to consume, and, second, that the best interests of agriculture are served by producing the various amounts of commodities needed on lands best suited to production, and by dividing the aggregate amounts to be produced among the producers on some sort of a quota basis.

It is with the administration of the second premise that the agricultural engineer and the farm manager are concerned. It is their job to plan the production on the 6,000,000 farm units in this country, and direct the use of the 1,000,000 tractors, 17,000,000 horses and mules, and other production equipment, in such a manner that there is produced the desired amounts of the various farm products, and that in so doing we still maintain the fertility of our soils.

Obviously such a task presents manifold difficulties. It is probable that many of the plans to be tried will work with only a fair degree of success, but if more effective land-use planning will result in any improvement whatever, it will be worth the effort.

We consider it desirable that land-use planning be directed along lines wherein there will be encountered the least conflict with established practices. Therefore, we wish to suggest a few requirements or conditions, which from the standpoint of the farm manager are desirable, in order to make land-use planning practicable.

In the first place, it appears imperative that the self-interest of the individuals involved in any scheme of land-use planning be recognized and provided for. This means that plans, to be acceptable, must benefit the individual. Furthermore, the benefits must be immediate, or at least readily recognizable. The wide acceptance given present voluntary acreage reduction programs as against previous "warnings" of overproduction is ample evidence on this point.

The matter of self-interest becomes a particularly ticklish item in any plans involving moving farm fam-

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[9]Agricultural engineer, Doane Agricultural Service. Junior A.S.A.E.

ilies from one location to another, or radically changing the type of production carried on. Individuals are often sentimentally attached to the places where they are and are reluctant to move. Also, with many individuals the "habit" to do as they always have done is often responsible for such a lack of cooperation with any new practice or system, that the improvement contemplated in the change may be defeated. Therefore, such changes as are contemplated should be worked in gradually, and each step should have some features about it which make it advantageous to the individual to follow.

Another item of importance is that land-use planning should be laid out on broad guiding principles and leave the actual details of management and operation to the farm operators themselves.

Nothing is more disturbing to the smooth running of a farm business than piecemeal interfering, such as admonitions to lay out these acres or that field, cut down on fertilizer, or eliminate this sow or that cow. It upsets rotations, unbalances labor requirements, and disturbs livestock projects.

Instead, the plans should provide for the production of so many bushels, bales, or pounds, and leave it up to the operator to use as many or as few acres, as much or as little fertilizer, and as many or as few breeding animals as suit his conditions.

We follow the practice of furnishing only general plans in our own work. In working out a farm operating program as much of the combined talent of our staff is put on the problem as is deemed necessary. Then the manager or operator is allowed to work it out with only general supervision. We find this plan gets more satisfactory results than to attempt to direct all the details of operation, and we believe the same is true generally.

Of course, if we are to control farm products without controlling the acres planted or the animals bred and fed, it is going to be necessary to control the amounts marketed. While this involves many difficulties, we believe it is more acceptable to the majority of farm managers than any plan involving interference with the details of how farms are operated.

This means that what surpluses there are would be stored or retained on the farms. After a farmer had marketed his "quota" or allotment, the balance would be held until such time as a market is created.

Such a requirement would soon make surpluses a matter of relatively minor importance, as there would be no incentive to indefinitely produce more than could be sold. It would lead to substitution of other crops for which there are markets, so as to supplement income, and would encourage the establishing of fertility-maintaining and erosion-preventing rotations, thus contributing to another of the objectives of land-use planning.

In our opinion, the fact that it has always been possible to sell a bushel of wheat or a bale of cotton for cash at some figure has been one of the greatest contributing causes to surpluses. Mortgage harrassed farmers have cropped their land to the limit to meet interest payments, knowing that, while other farmers were doing the same and thus forcing the price down, as far as they individually were concerned two bushels would always pay more interest than one.

We believe that, as a matter of fact, to simply control the acres of crops does not eliminate soil-depleting cropping methods, nor does it effectively control amounts of products. If it is just the acres we are required to reduce, there will still be no incentive not to abuse the land we do crop, and in many cases it will be possible by more effective methods, soil improvement, and better seed to produce just as many bushels on the lesser number of acres.

Thus land-use planning which involves interference with the details of operation is not only objectionable to operators, but will fail to accomplish the control desired.

A further requirement is that land-use planning should be national in scope and should embrace the entire agricultural industry.

There have been several attempts of states and sections to survey and classify their agricultural resources as a basis of prescribing plans for more effective land utilization. These surveys are valuable as guides to adaptability. However, as guides to farm management they are not apt to be generally accepted. We are reluctant to cut down production, when we know that in some other state or section production will be maintained or perhaps increased, and thus our competition will be increased. Furthermore, we are reluctant to go into production on a new crop recommended as being adapted to a section, without some assurance of markets. A national plan with a known degree of acceptance among producers would obviate some of this difficulty.

The same kind of difficulty may be encountered in attempting to control one product while other products are not controlled. We have recently seen cattle sell at fair prices while hogs were very low, a decidedly unsatisfactory condition.

Disparities between agricultural products must be controlled in order to make plans work to best advantage, and this can be done only if all major products are in the plans.

A further reason for the necessity of controlling all products is that farmers themselves are users of other farm products. Cotton producers want cheap wheat, and wheat producers want cheap cotton, and so on with other products. It would appear necessary to get them all in to give a fair deal to all.

Finally, we would like to suggest that as farm managers and operators we have a deep-seated aversion to any plan which involves actual waste of farm resources, as is contemplated in retirement of productive land or in destroying crops. These measures should be practiced only temporarily and should be avoided in permanent planning.

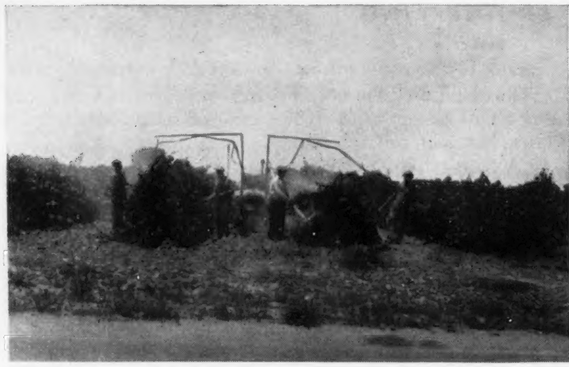
We want to operate our productive land and retire only the poor. We are willing to change from crops of which there is too much to others for which there are markets. Also, we are willing to try to adapt present crops to better fit new uses which the engineer, chemist, or other technologist may find for them. But to waste potential farm income is to us incompatible with good management.

Furthermore, we really do not believe that our agricultural resources are any in excess of the requirements of our population, if these resources are devoted to the production of usable commodities, and if our distribution system is such that they can move from producer to consumer at fair prices to both.

Therefore, we would like to see all productive land used. If a surplus is created sometimes, it should be held by the producers instead of marketed. We believe the depressing influence of surpluses on price is not so much due to the existence of the surplus as to its presence on the market.

There is some merit in the accumulation of surpluses. They create a backlog to carry us through short crop years such as the present one seems destined to be.

Therefore, instead of taking land out of use because there is too much production, we should work out some way to prevent the surplus from upsetting the marketing of the normal production.



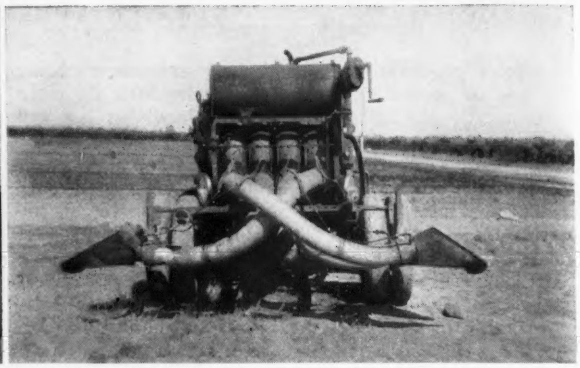


FIG. 1 (LEFT) A COMPRESSED-AIR SPRAYER, COMMERCIALLY MANUFACTURED. FIG. 2 (RIGHT) A BLOWER-TYPE SPRAYER, COMMERCIALLY MANUFACTURED AND OPERATED

Machinery for Applying Atomized Oil Spray

By Orval C. French[1]

EXPERIMENTAL work to develop a sprayer that will successfully apply a straight petroleum oil as a very fine mist or fog has been in progress in California since 1930. It was started by insecticide companies for the control of the grape-leaf hopper [*Erythroneura Comes (Say)*]. Recently the method has been successfully used for controlling San Jose scale and certain truck-crop pests.

The oil must be finely divided into a mist and then carried by means of an air blast to envelope completely the vines or trees. For grapevines, as little as 3 to 5 gal per acre is applied; for trees, 8 to 12 gal per acre.

During the past three years, insecticide companies have been responsible for the development of many machines for spraying atomized oil. The sprayers fall into four general classifications: (1) The compressed-air or paint-gun type (Fig. 1), (2) the blower type (Fig. 2), (3) the airplane, and (4) the hand knapsack. This paper presents the results of tests on the first two.

The compressed-air sprayer consists of an air compressor driven by a 12 or 15-hp gasoline engine. The nozzles, hand operated, are merely two jets, one for air and the other for oil. The oil is not under pressure, but flows partly because of gravity and partly because of a slightly less than atmospheric pressure created by the high velocity of the air over the oil jet. To operate a two-row vineyard machine, five men are used. The rate of spraying is from 2 to 3 acres per hour.

The blower type of sprayer forces the oil out through a nozzle that is surrounded by an air blast of relatively large volume and high velocity but low pressure. The oil is partially atomized in passing through the oil nozzle and further atomized by the air blast in leaving the air-discharge nozzle. The large volume of air (as much as 1,600 cu ft per nozzle) carries the oil particles in a cloud or mist to the vines or trees. These sprayers are operated by one man, and the nozzles are stationary. To drive the blowers, engine sizes to 40 hp are required. These machines can cover from 6 to 10 acres of grapevines per hour.

The airplane, although not extensively used for oil spraying, undoubtedly has potential merits. Thus far wind conditions have been a limiting factor. With low winds it has been satisfactory, but such conditions do not often prevail. A wire brush driven by a small propeller is used to atomize the oil. The propeller also furnishes power for a small centrifugal pump that drives the oil into the hub of the wire brush and forces it out along the wire bristles, thence to be thrown off the periphery of the brush. Such devices are suspended under each wing. The planes, flying at 90 to 115 mph (miles per hour), cover approximately 90 to 100 acres per hour.

Knapsack sprayers, being relatively inexpensive, have been used by small vineyardists during this past year. However, they do not give satisfactory atomization as now made, chiefly because of low and non-uniform pressures.

Since 1932, the Division of Agricultural Engineering and the Division of Entomology and Parasitology of the University of California have been cooperating in a study of grapeleaf-hopper control methods. At the time this study was undertaken, it seemed logical to approach the problem by determining the characteristics of various oil-atomizing sprayers and their correlation with leaf-hopper control.

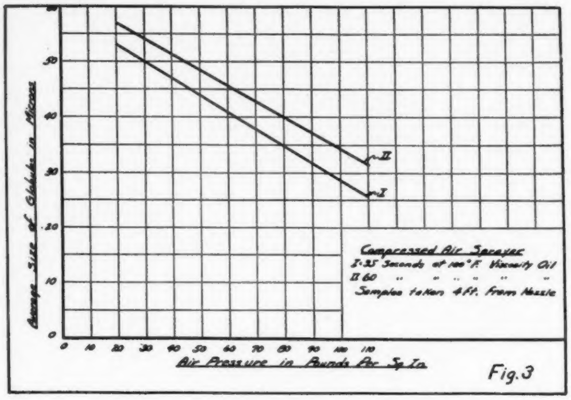
As the size of the oil-spray globule is apparently an important factor in the efficacy of sprays, studies were made to determine it for different sprayers and for different adjustments of a given sprayer. A method for field as well as laboratory studies was developed.

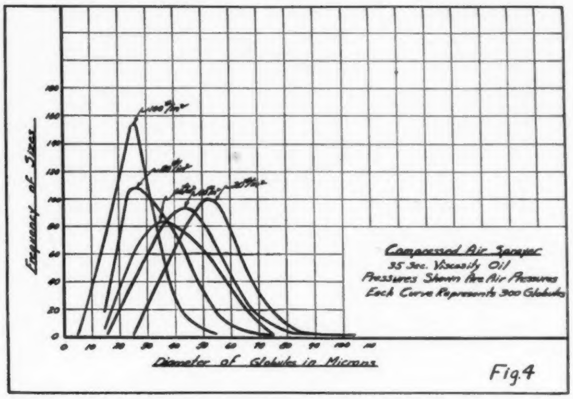
First, an attempt was made to determine oil-globule size photographically. This method was abandoned, however, as presenting complex difficulties and also as being useful only in the laboratory. The next method tried was that of using microscope slides coated with lampblack to collect the spray globules and then measuring microscopically. Engine designers[2] have found this procedure very satisfactory in studying fuel-spray formations.

The lampblack is applied by passing an acetylene flame over the slides for a period of two minutes. Although different thicknesses of lampblack make no apparent difference in globule measurement, it seems desirable to have all

[1]Instructor of agricultural engineering, and junior agricultural engineer in the experiment station, University of California. Jun. A.S.A.E.

[2]Lee, Dana W. "Fuel Spray Formation." Trans. A.S.M.E. (Oil and Gas Power) 54: 63-73. illus. 1932.





FIGS. 3 AND 4 THE RELATIONSHIP BETWEEN AIR PRESSURES AND OIL-GLOBULE SIZES FOR COMPRESSED-AIR SPRAYERS

slides alike. The oil globules are collected on these slides by quickly exposing the latter to the spray fog.

The spray globules were measured by placing the exposed slide under a Ziess microscope with an epi-mirror attachment. With this type of illumination, the impressions made by the oil drops appeared jet black, and the other portions of the slide light gray. The black impressions were measured with a filar micrometer eyepiece, by which those as small as 5 microns are measured easily. One advantage of this method is that the slides can be exposed in the field and then taken to the laboratory for examination; the slide records the imprints of drops much as does a photographic film. No change in size occurs after exposure.

Compressed Air Sprayer Tests. The relation between air pressure and the size of oil spray globules and between oil viscosity and size of globule was determined for the compressed-air sprayer. For each air pressure indicated, three miscroscope slides coated with lampblack were exposed to the spray at a distance of 4 ft from the nozzle. The results are shown graphically in Figs. 3 and 4. The relationship between air pressure and globule size is a straight-line function. As the pressure was increased, the globule size decreased, as did also the range of globule sizes. The entire range of average globule sizes for this sprayer falls within what is called a dry-spray class. That is, the spray is very fine and, unless applied in one place for a considerable length of time, does not wet the foliage to the extent that oil is visible.

Very little difference in average globule size resulted when oils of two different viscosities, namely, 35 and 60 saybolt seconds at 100 deg F, were used. Since most oils employed as atomized sprays fall within this range of viscosity, no other oils were tested.

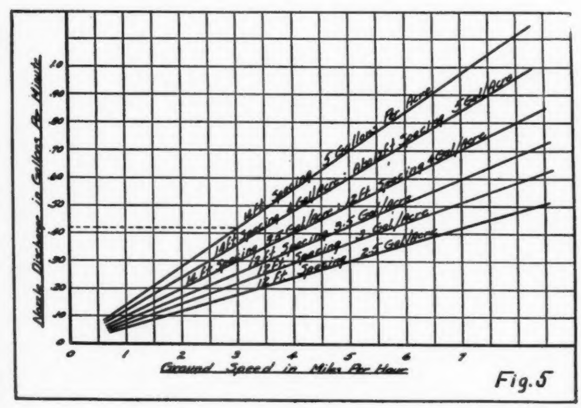
The air pressure most commonly used with this sprayer is between 60 and 90 lb per square inch, since higher pressures cause the spray fog to travel farther and to cover more area. Thus the sizes of globules used in the field average between 30 and 45 microns.

Blower Sprayer Tests. The plan of these tests was to determine data to show the relationship between

1 Speed in miles per hour of travel, vine-row spacing, spray material per acre, and nozzle capacity
2 Nozzle capacity and size of oil-spray globules
3 Air velocity and size of oil-spray globules
4 Oil pressure and size of oil-spray globules.

By knowing these relationships or characteristics, the machine operator can no doubt meet many specifications demanded by the entomologist.

A chart (Fig. 5) was prepared to show the gallons of oil per minute required to apply a given quantity per acre on different vine-row spacings at varying speeds. Since the ordinate values for nozzle discharge are quite small, nearly all being less than one gallon per minute, a special nozzle had to be obtained for such small quantities and for variation of oil discharge. A Chipman disk type of nozzle seemed most desirable. Since the Chipman standard disks had capacities too large, a series having smaller size orifices had to be made. Those finally developed would throw a



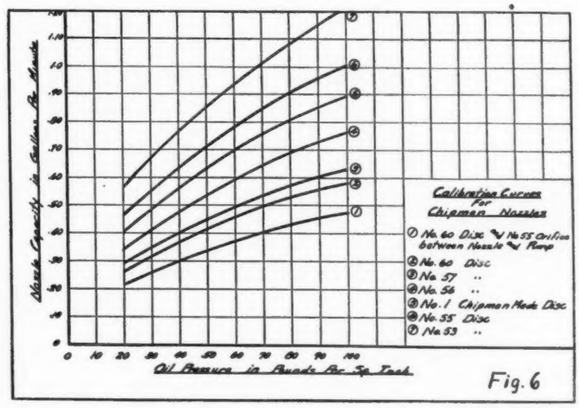
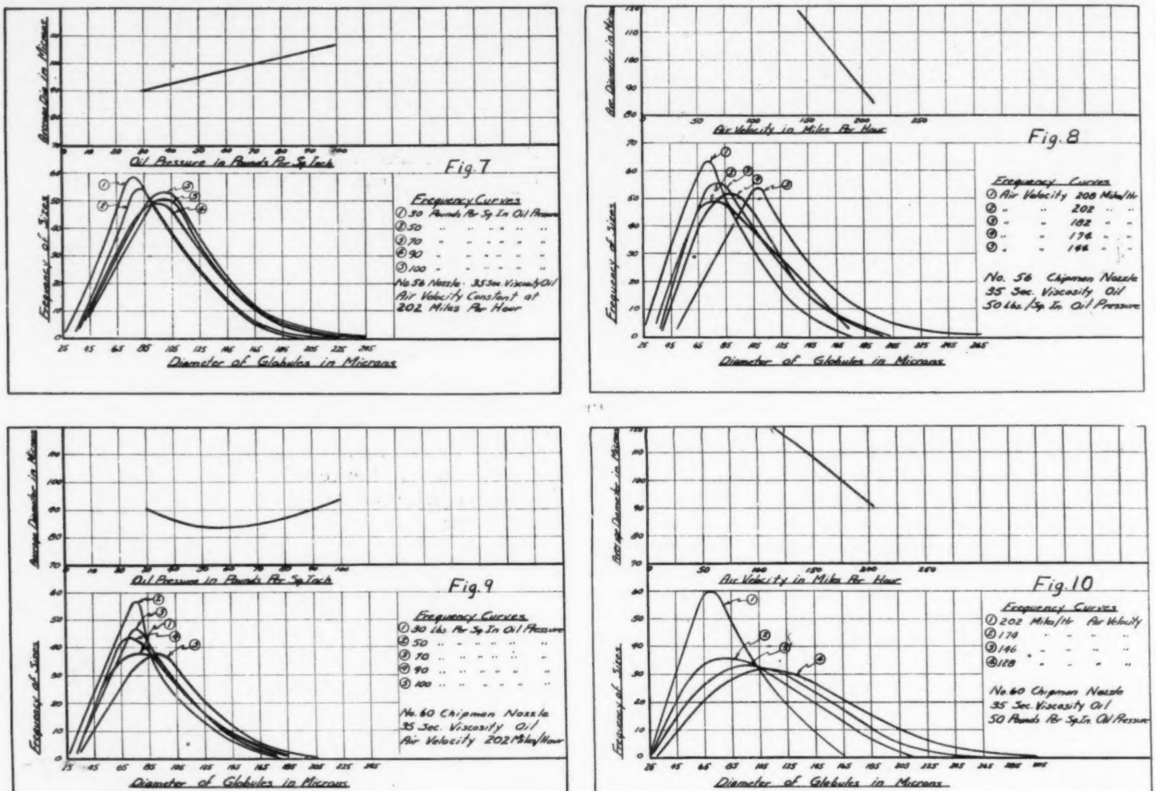


FIG. 5 (LEFT) A CHART TO DETERMINE NOZZLE DISCHARGE FOR VARIOUS FIELD CONDITIONS. FIG. 6 (RIGHT) CALIBRATION CURVES FOR CHIPMAN NOZZLES



FIGS. 7, 8, 9, AND 10 RESULTS FOR TESTS OF THE BLOWER-TYPE SPRAYER

flat fan-shaped spray at the angle necessary to fit the fan-shaped air nozzles on the blower-sprayer air outlets. The calibration curves for the various sizes of disks are shown in Fig. 6. By taking the quantity of oil required per minute from Fig. 5 and then referring to Fig. 6, one can choose a disk and also the pressure needed to meet the desired conditions.

The data showing the relation between oil pressure and size of spray globules are summarized in Fig. 7. Conditions under which this test was made were as follows: (1) Air velocity, 202 mph; (2) air-nozzle outlet dimensions,

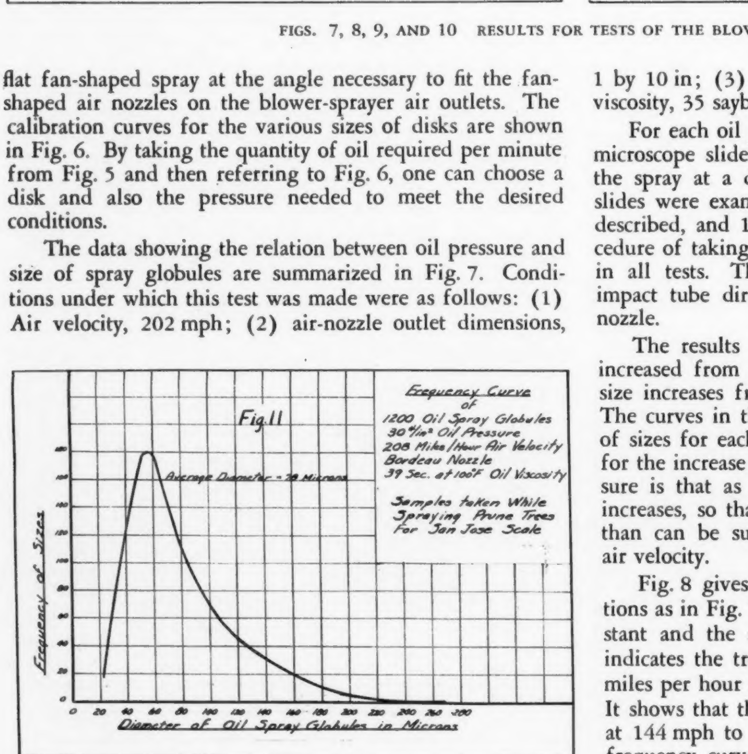


FIG. 11 RESULTS OF A FIELD TEST OF A BLOWER-TYPE SPRAYER

1 by 10 in; (3) No. 56 Chipman oil nozzle, and (4) oil viscosity, 35 saybolt seconds at 100 deg F.

For each oil pressure shown to the right of Fig. 7, four microscope slides coated with lampblack were exposed to the spray at a distance of 21 ft from the nozzle. These slides were examined under the microscope, as previously described, and 100 globules measured on each. This procedure of taking slides and making their analysis was used in all tests. The air velocities were measured with an impact tube directly at the point where the air left the nozzle.

The results (Fig. 7) show that as the oil pressure is increased from 30 to 100 lb per square inch the globule size increases from an average of 90 up to 107 microns. The curves in the lower portion of Fig. 7 show the range of sizes for each sample of 400 globules. An explanation for the increase in size of globule with an increase of pressure is that as the pressure is increased, the flow of oil increases, so that more oil is delivered into the air stream than can be sufficiently atomized without an increase in air velocity.

Fig. 8 gives the results of a test with the same conditions as in Fig. 7, except that the oil pressure was held constant and the air velocity was varied. The upper curve indicates the trend of the relation between air velocity in miles per hour and the average diameter of spray globules. It shows that the globule size decreased from 118 microns at 144 mph to 85 microns at 208 mph. Again, the lower frequency curves represent the range of sizes of globules for each air velocity. *(Continued on page 329)*

New Ideas in the Construction of Low-Cost Concrete Floors[1]

By W. G. Kaiser[2]

THE UTILIZATION of precast concrete joists in the construction of concrete floors is a development of special interest to farm structures engineers. Because of the economy and simplicity of this method of construction, the use of concrete joists greatly extends the field in which concrete floors may be used.

Precast-joist concrete floors consist primarily of precast joists and job-placed or precast unit slabs. The joists are set in place on supporting walls and girders much in the same manner as bar joists or wood joists. For relatively light loadings, such as occur in residences and for floor spans up to 18 ft, it is usual practice to specify 8-in joists. For heavier loadings and wider spans, 10 and 12-in joists are used. Usual spacing of joists is from 24 to 30 in. Slab thickness is 2 or 2½ in, the greater thickness being used for the wider joist spacings and when conduits are inclosed.

The modified I section is the most common shape, although some joists are made with rectangular, T-shaped, and other cross sections. The relatively thin web section of the I-beam type joist results in a lighter, more easily handled unit, and the shoulders formed at the junction of the web section and joist heads provide convenient supports for the spreaders which hold up the forms for casting the floor slab.

Form work in this type of construction is carried by the joists. Mud sills, shoring, or other underpinning usually are not required. The saving in form costs is one of the factors which accounts for the low cost of precast-joist concrete floors. Other factors are relatively low dead load, ease of construction and the rapidity with which the floor can be built. Two men can readily handle an 8-in joist up to 18 ft in length. Made with cinders, burned shale, or other lightweight aggregates, an 8-in I section joist of that length will weigh approximately 235 lb, or 13 lb per lineal foot. When made of sand and gravel aggregate, an 8-in joist weighs around 18 lb per foot. A 10-in joist weighs 17 and 23 lb per running foot, respectively, according to whether light or heavy aggregates are used, and 12-in joists approximately 26 and 35-lb per lineal foot.

The accompanying detail shows typical cross sections of 8, 10, and 12-in joists. It also shows the position of the reinforcement in the upper and lower heads and in the web sections. The tension steel in the lower head is varied in size from ½ in up to 1 in, according to loading and span of the floor. A ⅜-in bar is used in the upper head for joists of all sizes and lengths. Shear reinforcement consists of ¼-in rods bent around the upper and lower bars as shown and projecting above the joist, forming a loop. Chairs, consisting of quarter-inch rods bent as shown, are slipped on the lower tension rod at the time the steel is fabricated. These hold the steel assembly in the proper position when the forms are being filled with concrete.

The present practice is to make the joist to suit the job. Joist manufacturers have prepared tables showing the proper reinforcement for different loadings and spans. Casting of the joists is usually accomplished in gang molds using either wood or steel cores. Wood forms are somewhat less costly to make than steel molds, but the latter will give much longer service. Placing of concrete may be done by hand spading, but better results ordinarily can be obtained by mechanical vibration, which increases strength and density, improves appearance, and reduces manufacturing costs.

In designing the mix for making joists, the manufacturer keeps the following objectives in view:

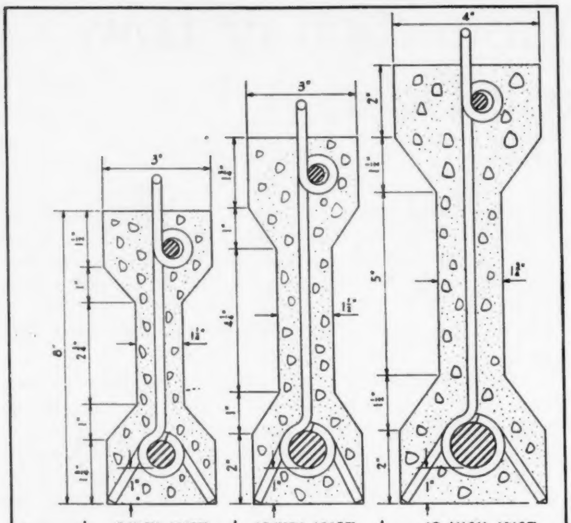
1 To produce concrete with a compressive strength of at least 2,500 lb per sq in at the time the joists are delivered on the job.

2 To produce a concrete mix of such workability

[1]Paper presented before the Structures Division at the 28th annual meeting of the American Society of Agricultural Engineers, at Detroit, Michigan, June 1934.

[2]Agricultural engineer, and manager of the cement products bureau, Portland Cement Association. Mem. A.S.A.E.

A GANG MOLD FOR MAKING CONCRETE JOISTS. (LEFT) CONCRETE BEING PLACED IN THE MOLD. (RIGHT) FORMS BEING REMOVED; NOTE ALSO THE STEEL REINFORCING ASSEMBLY AT THE LEFT OF THE JOISTS



	8 INCH JOIST		10 INCH JOIST		12 INCH JOIST	
SECTIONAL AREA	17.4 SQ.IN.		22.1 SQ.IN.		33.4 SQ.IN.	
AGGREGATE	LIGHTWEIGHT	ORDINARY WT.	LIGHTWEIGHT	ORDINARY WT.	LIGHTWEIGHT	ORDINARY WT.
AVERAGE WT. OF JOIST PER LIN. FT.	13	18	17	23	26	35

DETAILS OF TYPICAL CROSS SECTION OF 8, 10, AND 12-IN PRECAST CONCRETE JOISTS

and consistency that the molds can be filled completely and the reinforcing steel thoroughly covered.

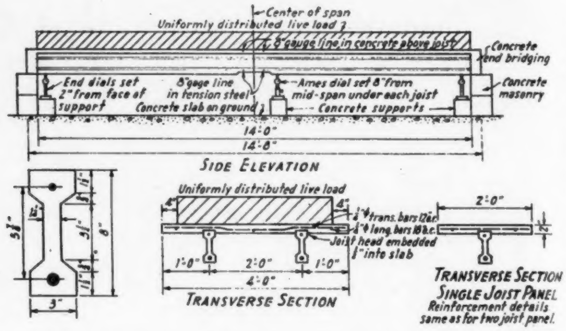
3 To secure joists with smooth surfaces, without honeycombing, when the molds are removed.

Experience has shown that a mix consisting of one volume of portland cement and three volumes of dry, rodded aggregate—with sufficient water added to obtain, after thorough mixing, a slump of about 8 in—will be satisfactory for hand-placed concrete. The use of mechanical vibration to settle the concrete makes it possible to use a mix of approximately one volume of cement to four of dry, rodded aggregates. Less water is added, as a very stiff concrete can be placed by vibration.

Usual procedure in the construction of a precast-joist concrete floor is as follows: The concrete joists are set in place on the supporting walls or girders much in the same manner as wood joists; spacing is from 24 to 30 in, according to load and span. Joists are accurately spaced and held in place during construction by means of braces near the middle of the span and at right angle to the joists. These are firmly fixed in position by wedges, which also permit quick removal of forms.

Next, spacers cut from 1-by-6-in boards are fitted between the joists. These, spaced approximately 3 ft apart, support the 1-in sheathing to form the bottom of the floor slab. This should be of dressed and matched lumber in case the lower side of the floor slab is to be left exposed. Where a very smooth surface is sought, the sheathing may be covered with waterproof building paper, in which case tight joints between form boards are not so necessary. Ordinary building paper will not be satisfactory, because it will wrinkle when wetted by the concrete and creases will be left in the slab.

Forms are quickly removed by tapping out the wedges, removing spreaders, and dropping the sheathing. Where a plastered ceiling is desired, wire hangers are placed over the joists for attachment of the metal lath, on which plaster is applied. Attractive beamed ceiling effects may be



DETAILS OF CONCRETE PANELS AS ARRANGED FOR LOAD TESTS

obtained without the use of plaster, and with a corresponding saving in cost.

Specifications usually require a concrete with a compressive strength of 2,000 lb per sq in for the slab, which is made 2 or 2½ in thick, depending on joist spacing and whether or not it is to inclose conduits. The head of the joist projects about ½ in up into the slab to secure more complete concrete-to-concrete bond between the joist and slab. This bond is essential in order to develop T-beam action between the slab and joist. The projecting loops of the stirrup in the joist help to increase this bond strength. Tests in the Portland Cement Association research laboratory and in other testing laboratories indicate definitely that T-beam action is obtained and that the floor can be designed on that basis. The floor slab is reinforced both ways with ¼-in rods at 10-in centers.

Any of the common floor finishes or coverings may be used. The slab may be trowelled smooth, or colored concrete finished smooth or marked off into patterns to simulate tiling or flagstones, or the surface may be covered with tiling, linoleum, overall carpeting, etc. Where hardwood finishes are desired, sleepers are built into the slab to which the floor boards can be nailed.

To secure definite data on the behavior of precast-concrete joist floors, some loading tests were made on panels 14 ft long and 4 ft wide (two joists) in the Portland Cement Association research laboratory. Results of these tests are reported by R. E. Copeland and P. M. Woodworth in the March-April 1934 Journal of the American Concrete Institute. The test panels were designed for a live load of 85 lb per sq ft, uniformly distributed. Deflection and strain gage readings were carefully measured after each increment of loading, and showed:

1 The performance and results as to load capacity, deflection, and measured stresses of panels with or with-

TABLE 1 RESULTS OF FLOOR LOAD TESTS

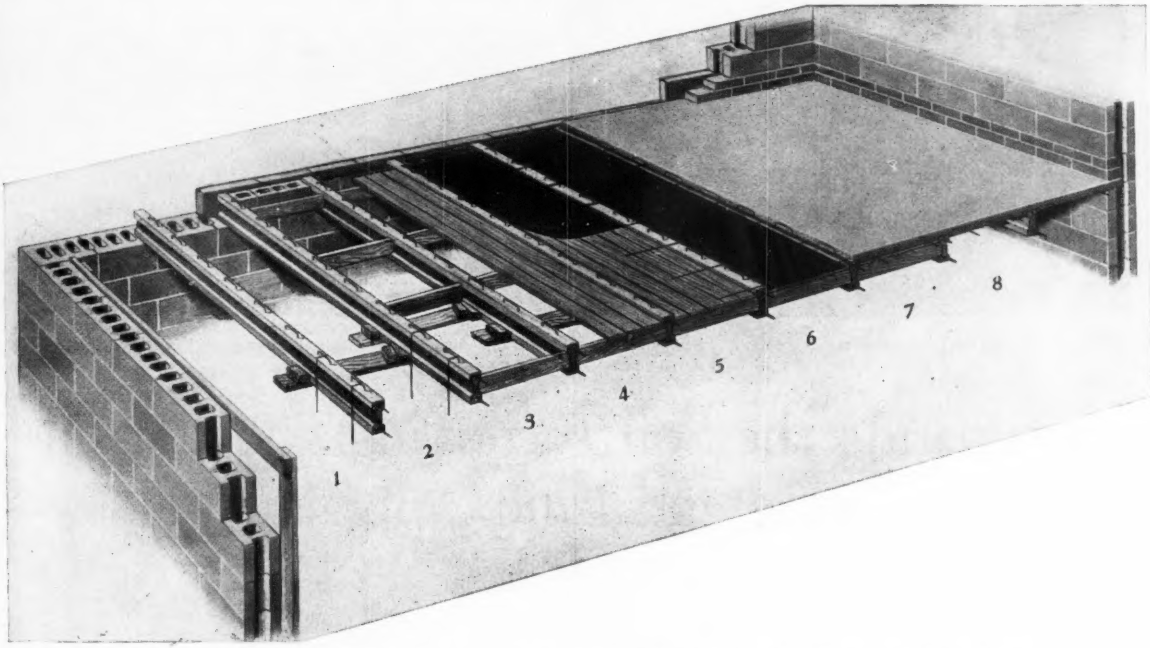
(Panels uniformly loaded with concrete block separated to prevent arching)

Panel No.	Ultimate load, lb per sq ft	Ratio of ultimate load to 85-lb live load*	Midspan deflection 40-lb live load
1-1**	160	-	0.093 in.
1-2	320	3.7	0.067 "
2-1***	160	-	0.060 "
2-2	240	2.8	0.096 "
2-3	300	3.5	0.050 "
3	280	3.3	0.072 "
4	280	3.3	0.059 "
5-1	292	3.4	0.044 "

*Allowable live load based on F's of 20,000 psi.

**Not loaded to failure.

***Not loaded to failure. Panel sustained load of 160 lb per sq ft for 7 weeks with no apparent distress.



THIS ILLUSTRATES THE VARIOUS STEPS TAKEN IN THE CONSTRUCTION OF A PRECAST-JOIST CONCRETE FLOOR

out metal ties, indicated sufficient joint strength and interaction between slab and joist to permit the use of the usual flexure formulas and allowable working stresses for T-beams in the design of floors of this type.

2 With all panels tested, the deflection at design load was substantially less than $^1/_{360}$ of the span length, a deflection of $^1/_{360}$ of the span length being the commonly accepted maximum allowable deformation of floor joist. This limitation is predicated on the assumption that ceiling plaster will not crack when bending does not exceed that amount.

Precast-joist concrete floors will doubtless find their greatest usefulness in homes and apartment buildings, in the smaller commercial buildings of relatively light loading, say up to 100 lb per sq. ft, for loft floors in barns, in building flat roofs on hog houses, poultry houses and other farm structures.

The advantages of this type of construction in farm buildings are (1) added fire resistance, (2) greater durability, (3) lessened maintenance, and (4) greater rigidity.

Analysis indicates that the actual cost of a residence floor built with concrete joists will be approximately 25c per sq ft at existing prices of materials and wage scales. The following table gives an analysis of cost on a job in St. Louis:

Joist depth, 8 in	Joist spacing, 30 in	Clear span, 14 ft 0 in	Slab thickness 2½ in	Cents per sq ft of floor
Precast concrete joists delivered to job				10.0
Setting joists				1.5
Charge for use of forms				2.0
Placing and removing forms				3.0
Slab reinforcing steel in place				2.0
Concrete slab-material, mixing, and placing				7.5
Total cost per square foot of screeded surface				26.0

NOTE: For trowelled finish add 2c per sq ft. For cement topping, add 3c to 4c per sq ft.

Machinery for Applying Atomized Oil Spray

(Continued from page 326)

Figs. 9 and 10 show the results of tests with a No. 60 Chipman nozzle. The conditions were the same as described for Figs. 7 and 8, and the results are similar. The frequency curves show very well the effect of increasing the air velocity, particularly up to somewhere near a critical value. Curves 2, 3, and 4 are broad and cover a wide range of sizes, while curve 1 is peaked and covers a much narrower range.

Fig. 11 is included in this paper to show the correlation between results in the field and laboratory as well as showing that measuring more than 400 globules does not change materially the shape of the frequency curves. To make this work comprehensive, further tests will be made on other nozzles. Higher air velocities as well as larger volumes of air with less pressure will be used in order to keep the horsepower consumption from becoming excessive. To employ a larger volume of air at less velocity, other methods for atomizing the oil must be developed. Studies of the airplane and knapsack sprayers are contemplated.

Apparently, in order that the results of these studies may be of greatest value for pest-control methods, the entomologist should secure fundamental data on the toxicity of different-sized oil globules on various insects. This is a complex problem, but such information is very necessary if the efficiency of this type of pest-control apparatus is to be improved.

(LEFT) DATES INTERPLANTED WITH GRAPEFRUIT GROWING ON SOIL WITH AN INDEX RATING OF 100. (RIGHT) A BADLY ERODED SOIL WHICH IS OF LOWERED VALUE IN THIS CONDITION

Evaluating the Soil Factor in Land Classification and Land Appraisal[1]

By R. Earl Storie[2]

THERE HAS BEEN more and more urgent need for knowledge regarding the productive value of land within the past year or two. During this time farms have been taken over, in increasingly large numbers, by banks, insurance companies, mortgage companies, or other agencies holding mortgages on them. Irrigation districts and other organizations have been faced with the problem of the poorer lands not being able to stand their burden of taxation. Many of our counties find themselves with thousands of acres of delinquent tax lands on their books. Recent studies made by land economists in a number of states show that a considerable part of this acreage falls in the low land-value class. In many cases the appraisals for assessments were so high on these poorer lands that, when prices dropped following the boom period, they were unable to meet charges and were the first to fail to pay taxes and interest. The point I am stressing is that there is not enough range in the values that have been given between the high and low quality lands.

With the overproduction bugaboo and the low price situation staring us in the face, there is still more urgent need for knowing the productive capacity of lands. Use of the poorer lands, often referred to as "submarginal," has greatly increased the agricultural output of the country and helped lower prices. We as scientists and agricultural engineers can supply *certain facts* in our studies of the situation so that a sound land-utilization program may be built up. Better methods in land classification and land evaluation can be developed, with supporting data and maps showing the soils, topography, and climatic factors that govern or regulate the use and value of land.

The preliminary steps in any land program is land classification, and soil classification is the basis on which any system of land classification is built. The value of rural land should be based on the producing power of the soil. If the soil is good, we have a good foundation for crop production, but if the soil is poor, we have a decided handicap. As pointed out previously, not enough difference has been recognized between the different productive grades of land. Soil surveys, crop production figures, drainage, erosion, and irrigation studies now give us more data on which to base our evaluations. Much of this type of data has been collected by agricultural engineers or others closely associated with them. It is because of this close connection that I feel free, as a soil technologist, to present this paper before a meeting of agricultural engineers.

The soil is the most stable factor governing the value of land. Soil, topography, and some of the other physical features are essentially permanent and can be systematically appraised from an engineering standpoint. We have tried to keep these stable factors separate from the less stable economic conditions, such as the ability of the operator and seasonal or periodic price trends. For *long time loans*, for *land classification*, and for *determinations of land use*, studies of these stable factors become very important.

The development and use of a rating of soils on a comparative basis in California has materially aided us in our greatly increased work in *soil evaluation* and *land classification* that has arisen the past year[3]. It has given us a yard stick, or "slide rule," with which to measure the relative value of soils. Assessors and appraisors in particular are very desirous of having some tangible rating for these values, and the soil rating gives them a logical basis for this.

In establishing these relative soil ratings, we base them on the characteristics of the soil itself, by assigning percentage values to the characteristics of the soil profile (Factor A); the texture of the surface soil (Factor B); and to modifying conditions such as drainage, alkali, erosion, etc. (Factor C). Each is evaluated on a percentage basis, the most favorable or ideal conditions being rated 100 per cent. The percentage values or ratings of Factors A, B, and C are then multiplied, the result being the *Soil*

[1]Paper presented before the Land Reclamation Division at the 28th annual meeting of the American Society of Agricultural Engineers, at Detroit, Mich., June 18-20, 1934.

[2]Assistant soil technologist, University of California. Mem. A.S.A.E.

[3]Shaw, Chas. F. The Storie Index Method of Soil Evaluation. Bulletin 15, American Soil Survey Association.

[4]Storie, R. Earl. An Index for Rating the Agricultural Value of Soils. University of California Agricultural Experiment Station Bulletin 556.

[5]Storie, R. Earl. The Classification and Evaluation of the Soils of Western San Diego County. Univ. Calif. Agr. Exp. Bull. 552.

[6]Carpenter, E. J., R. Earl Storie, and Stanley W. Cosby. Soil Survey of the Clear Lake Area, California. Series 9127, No. 13.

Index Rating of the soil (Table 1, taken from Bulletin 556 of the California Agr. Exp. Sta.)[4] The percentage ratings for the three factors are multiplied rather than averaged so that it permits any one of them to dominate the final index rating of the soil. This is a departure from the usual score card methods of judging and evaluating soils, in which the points credited to each of the soil's characteristics are added in order to get the soil rating. As an example, a soil may have an excellent profile condition warranting a rating of 100 per cent for Factor A, excellent surface soil conditions giving 100 per cent for Factor B, but a bad alkali accumulation that would give a rating of 10 per cent for Factor C. Multiplying Factors A, B, and C would give a final index value of 10, while under the usual score card method, with possibly 20 points ascribed to alkali, its rating would be 80. Obviously, heavy accumulations of alkali would dominate the soil, rendering it of very low value for any economic crop, and the low index rating of 10 would be justified.

The characteristics of the soil profile, which we rate first in this scheme, are essentially the features of the subsurface layers. These subsoil conditions which have been determined by the *kind of parent rock material*, its *mode of formation* or accumulation, and the age or degree of modification of the soil material by the weathering agencies of climate (supplemented by vegetation and opposed by erosion and deposition), divide the soil into groups of related individuals that are classed as *Series:* These are permanent soil conditions and not easily changed by man except in rare instances, for example, where a hardpan may be shattered by blasting or a thin or soft hardpan broken by deep subsoiling.

For our use in California, we have divided the soils into six groups, the grouping that we are using being as follows:

- Group I Soils with deep pervious subsoils
- Group II Soils with moderately dense subsoils
- Group III Soils having dense, slowly pervious claypan subsoils
- Group IV Soils having hardpans that are impervious to either roots or water
- Group V Soils having dense claypans, with subsoils resting on consolidated substratum
- Group VI Soils having bedrock substrata.

The soil series within each group are given ratings that depend on the character of the profile, particularly those of the *subsoils*. Profiles with deep subsoils that are pervious to roots and the movement of moisture are rated at 100 per cent. (Listed in Group I under the heading of "Unweathered or Slightly Weathered Secondary Soil" on the soil rating chart, Table 1.) Profiles with dense clay subsoils or with hardpan layers are rated lower (Groups III and IV), the rating under Factor A being governed by the density of the claypan or the depth to the hardpan. Primary or residual soils which are handled in Group VI are rated at from 20 to 70, depending mainly on the depth to bedrock. We have worked out the series ratings for each one of the 250 soil series that have been mapped to date in California. It is not absolutely necessary that the soil series be known, as the necessary information can be secured by exploring the soil and subsoil by means of the soil auger, soil tube, or by the pick and shovel. In most ratings or appraisals of soil, the subsoil conditions usually get the least attention. Agricultural engineers are fully aware of this fact and know the importance of these studies in drainage and other land reclamation activities. The importance of the subsoil study is being brought out very forcibly in all attempts at alkali reclamation where a permeable subsoil is very essential for best results. In the soil survey reports, the subsoil conditions are usually described very fully, so that there should be no difficulty in rating on this basis where soil maps and reports are available. In rating humid soils the grouping might be slightly different, but I see no reason why the subsoil conditions in any place should not be rated in a similar manner.

Next we rate the soil on the basis of the characteristics of the surface soils, independent of the subsoils. This is designated as Factor B on the soil rating chart. It is a rating of soil textures, as well as other characteristics that are more or less dependent on texture, such as the hardness or softness of the soil aggregates, porosity, permeability to water, and the response to tillage operations. Soils having ideal conditions from the textural standpoint are rated at 100 per cent in Factor B, while soils having less favorable textures are rated lower. The medium-textured soils, such as the loams and silt loams, are rated the highest, and the extremes in texture, such as the sands and the clays, considerably lower. Textures are divided into four textural groups: medium, medium heavy, heavy, and light, with two additional groups to cover the textures that include gravel, cobble, or stones. The texture of the soil is permanent and not easily changed, except in stony soils, so that once rated this factor remains stable. The values given for the various textural grades in the soil rating chart (Table 1) are gathered from our study of California soils and their uses. In addition to the more permanent characteristics of the surface soil and the subsoils(Factors A and B) a number of less permanent conditions may exist that modify the value

TABLE 1

SOIL RATING CHART—FOR RATING OR JUDGING THE AGRICULTURAL VALUE OF SOILS
(Soil Index Rating = Factor A × Factor B × Factor C)

Factor A, Rating of soils on basis of character of profile

Soil group	Rating, in per cent
I. Unweathered or slightly weathered secondary soils	95-100
II. Moderately weathered secondary soils	80-95
III. Strongly weathered secondary soils with dense clay subsoils, developed on unconsolidated parent material	40-80
IV. Maturely weathered secondary soils with hardpan:	
Hardpan less than 1 foot	5-10
1-2 feet	10-20
2-3 feet	20-30
3-4 feet	30-40
4-6 feet	40-60
V. Strongly weathered soils having dense clay subsoils resting on consolidated material	20-40
VI. Primary soils underlaid by bedrock:	
Depth less than 1 foot	20-25
1-2 feet	25-40
2-3 feet	40-60
Over 3 feet	60-70

Factor B, Rating of soils on basis of surface texture

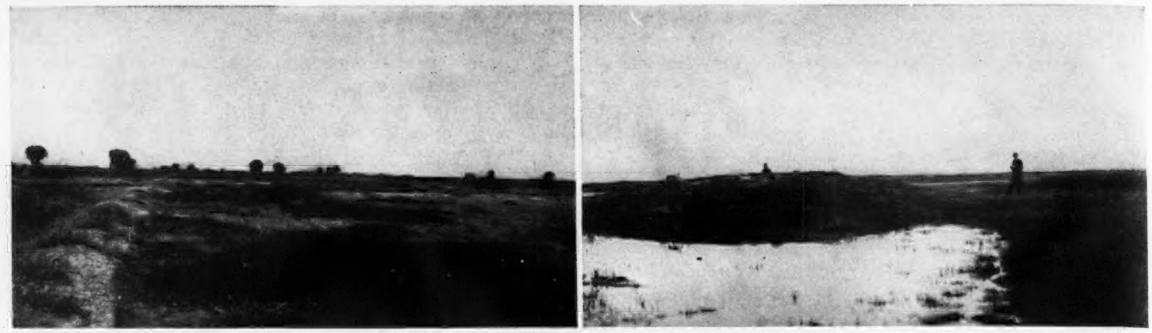
Texture	Rating, in per cent
Medium-textured:	
fine sandy loam	100
loam	100
silt loam	100
sandy loam	95
coarse sandy loam	90
loamy sand	80
Medium-heavy textured:	
silty clay loam	90
clay loam	85
Heavy-textured:	
silty clay	65
clay and adobe clay	50-70
Light-textured:	
very fine sand	80
fine sand	65
sand	60
wind-blown sand	20-70
Gravelly or cobbly:	
gravelly fine sandy loam	70
gravelly loam	70
gravelly silt loam	70
gravelly sandy loam	65
gravelly clay loam	55
gravelly clay	35
gravelly sand	20-30
Stony:	
stony fine sandy loam	70
stony loam	70
stony silt loam	70
stony sandy loam	65
stony clay loam	60
stony clay	35
stony sand	10-40

Factor C, Rating of conditions and characteristics of the soil which modify its suitability for utilization in plant production

Condition	Rating, in per cent
Drainage:	
well drained	100
fair drainage	80-90
moderately water-logged	40-60
badly water-logged	10-40
Alkali:	
alkali free	100
slightly affected	90
moderately affected	60
strongly affected	5-25
Acidity:	
according to degree	60-95
Infertility:	
according to degree	60-95
Stratified subsoils	60-95
Shallow phases of alluvial soils:	
2 feet deep	50-60
3 feet deep	70
Eroded soils:	
moderate	80-95
badly	30-80
Steep phases:	
fairly steep	60-80
steep	20-30

Miscellaneous nonagricultural material

Type	Description	Rating in per cent
Rough mountainous land	Rough mountainous topography	5-10
Scabland	Recent lava flows	5-10
Rough broken land	Steep slopes, eroded slopes, gullies, and canyon walls	5-10
Riverwash	Deposits of stream channels	1- 5
Placer diggings and tailings	Piles of stone and gravel	1- 5
Tidal marsh	Tidal lands	1- 5
Coastal beach and dunesand	Sloping beaches of sand, gravel	1- 5
Rough stony land	Rough stony slopes	1- 5



(LEFT) ALKALI SPOTS IN AN ALFALFA FIELD. THE RATING OF THIS PARTICULAR SOIL IS FAIRLY LOW. (RIGHT) LAND WITH "HOGWALLOW" TOPOGRAPHY HAVING A RED IRON HARDPAN AT A DEPTH OF 2 TO 3 FT BELOW THE SURFACE. NOTE THE WATER STANDING BETWEEN THE MOUNDS AFTER A RAIN

of the soil for plant production. While I may designate them as less permanent in relation to soil texture and soil profile characteristics, yet they are inherent in the soil and are definite *soil* characteristics. These are drainage, overflow, erosion, infertility, alkali, etc. These conditions we designate as Factor C on the soil rating chart.

To a considerable extent they are conditions that agricultural engineers are primarily interested in, particularly those of us in the Land Reclamation Division of the Society.

TABLE 2 SOIL RATING FOR A TRACT OF LAND

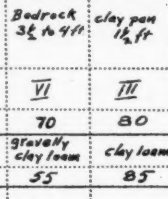
LOCATION AND DESCRIPTION John S. Smith Ranch Sec. 18 T13N R9W MDB

PURPOSE OF SOIL RATING Evaluation of Ranch

SOIL TYPE OR LAND TYPE DESIGNATION	Hugo gr. clay loam Hgrcl	Manzanita clay loam Mcl	Rough stony land R	Yolo fine sandy loam Yfsl
PROFILE CHARACTERISTICS Character of subsoil and substratum (Texture, Compaction, depth, etc.)	Bedrock 3½ to 4 ft	clay pan 1½ ft	very stony and rough	Deep, permeable uniform
SOIL GROUP (maturity of profile)	VI	III	M	I
RATING (PROFILE) FACTOR A	70	80	—	100
TEXTURE OF SURFACE SOIL	gravelly clay loam	clay loam	—	fine sandy loam
TEXTURAL RATING (FACTOR B)	55	85	—	100
CONDITIONS MODIFYING SOILS SUITABILITY FOR PLANT PRODUCTION Drainage, overflow; Erosion; Infertility; Steep phases; Shallow phases; Stratified subsoils; Toxic Conditions (Alkali (Acidity	Rolling surface eroded	✓	✓	well-drained, fertile
RATING (FACTOR C)	80	100	-	100
GENERAL SOIL RATING (SOIL INDEX) A x B x C	70x55x80=30	80x85x100=68	—	100x100x100= 100
RATING FOR MISCELLANEOUS NON-AGRICULTURAL CLASSES Scabland, Rough stony land, Rough broken land, Riverwash	—	—	2	—
PRESENT USE	Pasture	grain	none	alfalfa fruit
BEST USE WITH IRRIGATION	Fruit terraced	grain and shallow crops	none	wide use all crops
BEST USE WITHOUT IRRIGATION	Pasture and grain	grain	poor pasture	fruit grain
ACREAGE	100	100	200	240
SOIL RATING x ACREAGE (for each type)	3000	6800	400	24000

SUM OF ABOVE (X) 34200
TOTAL ACREAGE (Y) 640
AVERAGE SOIL RATING FOR TRACT $(\frac{X}{Y})$ $\frac{34200}{640} = \underline{53.4}$

MAP OF TRACT



LEGEND
Roads
Buildings
Soil Boundary

Hugo gravelly clay loam
Manzanita clay loam
Yolo fine sandy loam
Rough stony land

Scale in feet
0 2640 5280

In rating some of our humid soils, I find that these conditions are some of the most important factors governing the value of the soil for agricultural uses. Many of these soils may be rated high from the standpoint of texture and profile, but are poorly drained, badly eroded, or else the supply of available plant nutrients is reduced to such a point that the soil is relatively infertile. In many of our desert valleys of the West alkali often becomes the limiting factor in judging their value. Detailed alkali maps there are of great value in evaluating such conditions. We find more difficulty in rating these influences listed under Factor C because of the variability of the degree of intensity of these conditions, and are looking to agricultural engineers, who are working on problems such as drainage, erosion, etc., for help in establishing more definite ratings for these conditions. For example, it appears possible that for purposes of land valuation rating we could establish relative values of various heights of the water table from the surface. Much data has been secured in the past by soils men and reclamation engineers regarding these conditions, but there is still need for more specific information to guide us in land classification and land-use programs.

Table 2 illustrates the use that can be made of our soil rating scheme in arriving at the relative evaluation of a tract of land having a number of different soil conditions. This hypothetical farm has a total of 640 acres. A soil examination shows 100 acres of a residual gravelly clay loam soil with bedrock occurring at an average depth of 3½ ft and having a rolling surface which is eroded to a considerable extent. The index rating on this soil is calculated to be 70x55x8 = 30 per cent. There are 100 acres of a claypan soil mapped as Manzanita clay loam which is given a profile rating of 80, a textural rating of 85, and which has no other conditions lowering its value. This is given an index rating of 50x85x100 = 68 per cent. There are 240 acres of Yolo fine sandy loam. As indicated on the chart (Table 2), this is a deep, permeable alluvial soil of high value for a wide range of crops. It is given an index rating of 100x100x100 = 100 per cent. Had this soil been poorly drained, its rating would have been lowered. There are also 200 acres of rough stony land which is given a rating of only 2 per cent. Then by multiplying each soil rating by its acreage, securing the total of these and dividing this by the total acreage, we have 34,200 ÷ 640 = 53.4 per cent, which is the average soil rating for the farm. Such a system of farm land rating should prove useful in comparing and rating the conditions on various tracts of land for purposes of comparative evaluation.

This is a rating of the soil factor only. Land evaluation requires the inclusion of other factors such as water supply, climate, location, and a number *(Continued on page 334)*

TABLE 3. RATING AND GRADING OF A PORTION OF THE SOILS OF THE CLEAR LAKE AREA IN CALIFORNIA

Soil type	Soil group	Rating factors A	B	C	Index	Grade	Acreage	Remarks	Use: present, potential
Yolo fine sandy loam	I	100	100	100	100	1	2,496	Deep alluvium	Excellent for all crops
Cole fine sandy loam	II	90	100	80	72	2	3,264	Drainage restricted	Pears and general farm crops
Rincon very fine sandy loam	II	90	100	100	90	1	1,664		Wide range of crops
Clear Lake clay adobe	II	95	60	90	51	3	5,504	"	Limited in uses. Pears
Dublin clay adobe	I	95	60	90	51	3	1,600	"	"
Manzanita clay loam	III	80	85	100	68	2	6,144		Fairly productive for wide range of crops
Pinole loam	III	80	100	80	64	2	6,144	Somewhat lowered fertility	Good for grapes and prunes
Pinole loam (gray ph.)	III	80	100	60	48	3	640	Lowered fertility Drainage restricted	Only of fair quality
Konokti gravelly sandy loam	VI	70	55	100	39	4	13,824	Fairly deep residual soil	Mainly uncleared
Hugo clay loam	VI	60	85	100	51	3	11,712	3 ft deep	
Hugo clay loam (shallow ph.)	VI	25	85	100	21	4	5,952	Shallow residual soil	Grazing
Aiken clay loam	VI	70	85	100	60	3	3,520	3 to 4 ft deep	Soil productive but land is hilly
Aiken gravelly clay loam (stony ph.)	VI	50	55	100	27	4	2,688	Shallow	Grazing
Rough mountainous land					8	6	106,752	Non-arable	Non-arable. Some grazing
Rough stony land					3	6	18,752	Non-agricultural	Non-agricultural
Riverwash					1	6	896	"	"

TABLE 4. GRADES OF SOIL IN THE CLEAR LAKE AREA, CALIFORNIA, AS DETERMINED BY THE SOIL INDEX RATING

Grade	Index rating	Description	Acreage
1	80-100	Excellent soils. Suitable for a wide range of crops. Capable of intensive development under irrigation.	10,624
2	60- 80	Good soils. Suitable for most crops, although not quite so desirable or of as high general value as the soils of Grade 1, due to heavier textural types or lighter textured types, or heavier textured subsoils, etc. These soils are capable of development under irrigation.	34,048
3	40- 60	Fair soils. Limited in uses by extremes of texture, by drainage, by heavy textured subsoils, or by other soil factors. May give good results with certain specialized crops, but do not have the range in suitability as do the soils of Grade 2.	41,088
4	20- 40	Soils suitable for few crops except pasture grasses or timber, because of soil features or slope. Usually of poor quality.	32,960
5	Less than 20	Soils usually of very poor quality for any cultivated crops, due to shallowness, stoniness, roughness of surface, etc.	1,920
6	Less than 10	Non-arable types. Those having lowest ratings have little or no agricultural value.	126,400

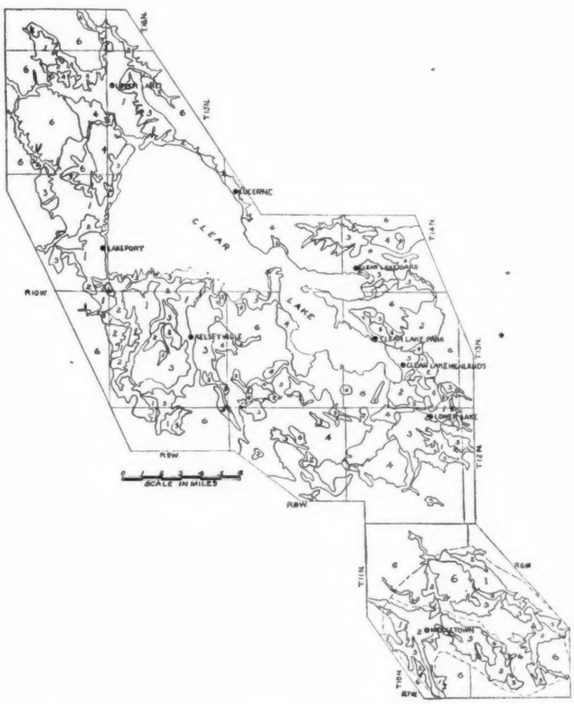


FIG. 1 MAP OF THE CLEAR LAKE AREA IN CALIFORNIA, SHOWING THE LOCATION OF THE DIFFERENT GRADES OF SOIL AS DETERMINED BY THE SOIL INDEX RATING. (FOR GRADES AND ACREAGE, REFERENCE SHOULD BE MADE TO TABLE 4)

(Continued from page 332) of economic considerations, yet with the soil as a basis we can build up a sound land classification and land evaluation scheme. In certain districts where the climate water supply, markets, etc., are all quite uniform, the soil index rating becomes essentially a land evaluation rating. In these areas we can secure the land evaluation by multiplying the soil index rating by the base value assigned to the best land of the area. If other conditions than the soil are variable, the value of land may be secured by zoning the agricultural areas. For instance, we might have the best land in Zone 1 appraised at $100 per acre; in Zone 2, at $75 per acre; in Zone 3, at $50 an acre. Then a soil type with an index rating of 50 per cent in Zone 1 would be valued at $50 per acre; in Zone 2, at $37.50 per acre; and in Zone 3, at $25 per acre. Such a systematic method of assigning land values by assessors could be easily explained to the owners so that there would be less chance for extended argument as the valuation would be based on facts and not on what someone thinks the land might bring at a sale. Guesses as to soil conditions and land value, based on a look at the particular crops growing when the appraisal is made, are often very misleading. With proper soil information, and data on the climate, water supply, and other physical factors, the potential producing power of a tract of land can be very readily ascertained and should be the basis for any schemes of land classification and land evaluation.

We have established basic index values for most of the soils of California, by rating the soils as mapped and described in the soil surveys made by the U.S.D.A. Bureau of Chemistry and Soils and the University of California. Table 3 shows the rating and grading of some of the soils of the Clear Lake area in California. Added information is given in this table as the total acreage of each soil type, and general remarks concerning the use to which it is put. After securing the index rating on each soil type we graded each type for land classification purposes[5]. Soils having an index rating of 80 to 100 per cent are placed in Grade 1, 60 to 80 per cent in Grade 2, 40 to 60 per cent in Grade 3, 20 to 40 per cent in Grade 4, less than 20 per cent in Grade 5, and less than 10 per cent in Grade 6 (shown in Table 4 for the Clear Lake area)[6]. Following this grading a map was made showing the location of the soils of each grade (Fig. 1). This information, along with the maps, should be of basic value in any land-use study, as it shows the relative value of each soil and its geographical location. Thus we are able to present the facts concerning the productive value of the land in a manner that can be satisfactorily applied with many and various uses.

When Will the Drought End?

By Dalton G. Miller[1]

IT IS SAID that devout Mohammedans never talk about the weather because to do so might be construed as criticising Allah. It is strongly suspected, though, that even a devout Mohammedan would occasionally say something about the weather were he farming in parts of the upper Mississippi and Missouri River basins during the hot dry season of 1934.

Undeniably many parts of the Middle West have been experiencing extremely dry weather this season. Unfortunately this area also has had precipitation quite generally below average for a number of years, or at best very slightly above average, so that soil moisture already was deficient. This year the accumulated effect of these dry years has been marked by the drying up of many wells, ponds, and lakes, and greatly lowering of water in many others.

The natural question in the minds of many is how long will the dry weather continue. There is no exact answer to this question, as accurate predicting of weather, beyond some three or four days, is not generally accepted as possible in the light of present scientific knowledge. Perhaps the nearest approach to any answer to the query is to be found after a study of existing precipitation records because the statement, "History repeats itself," certainly applies to weather. This does not mean that there are so-called "weather cycles," but it means that variations in precipitation, temperature, etc., in a given locality ordinarily range between well-established limits. The oldest known authentic continuous precipitation records in the Mississippi Valley are for St. Louis, Missouri, and for the Twin Cities (Minneapolis-St. Paul) area of Minnesota. Since we are most interested in conditions in Minnesota, we shall consider the records of precipitation for each of the past 97 yeears as recorded in the Minneapolis office of the U. S. Weather Bureau. There are also available records of 117 years for the Baltimore, Maryland, office of the U. S. Weather Bureau. Baltimore is a long way from the Mississippi Valley, and records at this station are considered chiefly because of their exceptional value due to the length of time they have been kept. Both sets of records clearly indicate that dry weather is not peculiar to recent years.

In particular, it is to be noted that the present dry period, which the upper Mississippi River basin is experiencing, is by no means unprecedented. As for example, the total precipitation for the twenty years 1914-1933, inclusive, has been 518 inches, while away back between the twenty years 1837-1856 it totaled but 501 inches. Also during the twenty years 1882-1901 the precipitation totaled 519 inches—only one inch more rain during this twenty years than has fallen during 1914-1933. Furthermore, during the ten years 1924-1933 the precipitation has totaled 246 inches, compared with a total of but 241 inches for the ten years 1882-1891. At Baltimore the records show that the total precipitation for the 58 years between 1817-1874 averaged 38.10 inches per year, while for the 59 years between 1875-1933, it averaged 42.59 inches—4.49 inches per year more during the past 59 years than during the 58 years ending 1875.

Casual study of the records for the Twin Cities area might lead to the conclusion that there had been a certain regularity of precipitation behavior on the order of cycles that could be used as a basis for a prediction as to when wetter years would reoccur. It is believed though that this is merely a coincidence, as the Baltimore records do not give an impression of cycles nor do records studied from a number of other long-established stations of the United States.

There is a measure of gratification to note that dry periods of the past eventually have been followed by wetter years, and it seems fair to conclude that this dry period likewise will come to an end. With wetter years should come a general rise of ground water, increased run-off, higher lake levels, and more water in wells and streams, although it is not possible to predict exactly when this will come about.

[1]Senior drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

KNOCK RATING OF GASOLINES MAY BE ESTIMATED FROM ANALYSIS, *A. W. Trusty.* Natl. Petrol. News, vol. 24 (1932), no. 51, pp. 29, 30, 32. This is a brief presentation of some of the salient facts regarding the relationship between the composition of gasoline and its knock rating. It is pointed out that knock ratings of motor fuels are determined by the percentage composition of the different types of hydrocarbons composing any particular gasoline. The knock rating of any fuel may thus be closely estimated from the results of an analysis of the constituent hydrocarbons present.

RESISTANCE TO SLUDGING, EXTREME LONG LIFE OF NEW SYNTHETIC OILS, *D. P. Barnard.* Natl. Petrol. News, vol. 24 (1932), no. 46, pp. 62, 64, 68, 72, figs. 2. Recent studies of the properties and performance of synthetic lubricants made by polymerizing cracked paraffin wax with anhydrous aluminum chloride as the reagent are briefly reported showing that these lubricants are extremely resistant to oxidation in service where the oil is exposed to oxygen at high temperatures and in finely divided condition.

Very low carbon formation rates are shown by these investigations, and the percentages of asphaltenes found after severe tests are particularly low when compared with similar results on regularly manufactured lubricants from all crudes.

TABLES OF DRAINAGE AREAS AND RIVER DISTANCES IN THE MISSISSIPPI RIVER SYSTEM, *M. W. Hayes.* U. S. Dept. Agr., Weather Bur., 1933, pp. 26. These tables include drainage areas of the eight principal basins comprising the Mississippi River system, drainage areas of subbasins, drainage areas above river gages, distances of gages above mouths of rivers, and distances between mouths of tributary streams.

PUBLIC ROADS, (December 1933) U. S. Dept. Agr., Public Roads, 14 (1933), No. 10, pp. 181-196 + [2], fig. 15. This number of this periodical contains the current status of U. S. Public Works road construction as of November 30, 1933, and the following articles: Laboratory Tests Assist in the Selection of Materials Suitable for Use in Mud Jack Operations, by A. M. Wintermyer (pp. 181-184, 194); Analytical Tools for Judging Results of Structural Tests of Concrete Pavements, by H. M. Westergaard (pp. 185-188); and An Improved Recording Strain Gage, by L. W. Teller (pp. 189-194).

SURFACE WATER SUPPLY OF THE UNITED STATES, 1932, Parts 10, 11. U. S. Geol. Survey, Water-Supply Papers 735 (1933), pp. V+107, fig. 1; 736 (1933), pp. XI+415, fig. 1. Part 10 of this report, prepared in cooperation with the states of California, Idaho, Nevada, Oregon, Utah, and Wyoming, presents measurements of flow made on streams in the Great Basin during the year ended September 30, 1932, and Part 11, prepared in cooperation with the states of California and Oregon, presents corresponding measurements for the Pacific slope basins in California.

THE ADJUSTMENT AND REPAIR OF MOWERS, *M. A. Sharp, V. S. Peterson,* and *E. G. McKibben.* Iowa State Col. Ext. Bul. 192 (1933), pp. 15, figs. 11. This bulletin covers the common adjustments and repairs of mowers in a popular manner.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE COLORADO STATION. Colorado Sta. Rpt. 1933, pp. 13, 14, 19, 20. The progress results of investigations of light asphaltic road surfaces, sugar beet machinery, measurement of water, water evaporation, irrigation pumping, and on the development of vortex-tube and riffle-deflector sand traps are briefly reported.

NEW DEVELOPMENTS IN HOG HOUSES AND EQUIPMENT, *F. Hale* and *H. P. Smith.* Texas Sta. Bul. 486 (1933), pp. 39, figs. 34. This bulletin describes and illustrates several new developments in hog houses and equipment adapted to Texas conditions. These include an improved A-type house adapted to all sections of the state. Improvements made on the shed-roof house were found to increase its adaptability to Texas conditions. Designs for extending the concrete floors 6 ft beyond the outside walls of the half-monitor and gable-roof houses are a new feature which prevents mud holes and rooting along the foundation. Better door and window installation and arrangement have been added.

A simple and inexpensive hog breeding crate, covered water trough, and two types of adjustable self-feeders that aid in economical hog production are described. Other useful equipment described includes weighing and shipping crates, loading chute, hog-killing equipment, and smoke house. Plans and bills of material are given for all houses and equipment reported.

A STUDY OF FIVE COMMERCIAL ELECTRIC STOVES, *A. E. Baragar* and *E. B. Snyder.* Nebraska Sta. Res. Bul. 68 (1933), pp. 62, figs. 45. Five commercial electric stoves having major variations in types of surface units, in the construction, lining, and insulation of the oven, and in the retail price were studied to determine (1) the efficiency and time of heating of the various surface units and (2) the merits of differently constructed ovens.

The efficiency and time of heating for both cold and hot starts for short-time tests of three types of surface units, namely, open type, solid cast type, and tubular or ring type solid, were found by heating successively 4, 3, 2, and 1 lb of distilled water from 72 to 206 deg F in various sizes and types of covered and uncovered aluminum and enameled pans. For long-time tests for both cold and hot starts the efficiency was found by heating 4 lb of distilled water in covered aluminum and enameled pans from 72 deg to the boiling point, after which the water was kept boiling for the remainder of the one-hour test period.

The results of the surface-unit tests indicated that units having a small watt rating are more efficient than units having a large watt rating. The tubular and the ring-type units are the most efficient for general use. Some open units were more efficient than others. The cone and reflector units are efficient for short-time processes when started cold, but for all other processes they are inefficient when compared with the other open-type units studied. The solid cast units are inefficient for cold starts, but for long-time processes they are very efficient. The utensils should have straight side walls, should not be too high, and should be of a size to fit the unit exactly. The cover should make perfect contact with the side walls. For short-time processes either enameled pans or black-bottomed aluminum pans should be used on open and tubular or ring-type units. For all solid cast units, aluminum pans with bottoms making perfect contact with the unit should be used. For all long-time processes aluminum pans should be used on all units.

The ovens were rated by determining and comparing, for empty ovens, (1) the time and energy required to preheat, (2) the total heat loss, (3) the heat loss per square foot, (4) the heat loss when the oven door was opened, (5) the time-rate of cooling, (6) the calibration of the thermostat, and (7) the temperature distribution in the oven for various average temperatures.

The results for the preheating tests, the heat losses, and the time rate of cooling are shown graphically. Thermostat and heat distribution results are shown in tables. Where a ranking involves time or energy the ovens are ranked in ascending order of the time and energy required. The results are mainly of a comparative character between the different commercial ovens, and no basic conclusions are presented.

ARTIFICIAL DRYING OF RICE ON THE FARM. *W. D. Smith, J. J. Deffes, C. H. Bennett, W. M. Hurst,* and *W. H. Redit.* U. S. Dept. Agr. Circ., 292 (1933), pp. 24, figs. 13. Investigations conducted by the U. S. D. A. Bureaus of Agricultural Engineering and Agricultural Economics are reported.

The results show that the method of combine harvesting and artificial drying, if properly carried out, eliminates damage to the rice from unfavorable weather, reduces loss from shattering, and produces rice of higher milling quality and a more uniform product than does the common method of harvesting with a binder. Tests made with both experimental and commercial grain driers show that in order to obtain rice of a high milling quality a much lower drying-air temperature must be used than is customary in drying other cereals. If a drying-air temperature as high as 120 deg F is used, the moisture content of rice should not be reduced more than about 2 per cent at any one drying operation, unless that content is considerably in *(Continued on page 342)*

AGRICULTURAL ENGINEERING

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RAYMOND OLNEY, *Editor*

R. A. PALMER, *Associate Editor*

The Speaker and the Machine

THOUGH a farm owner and known in his home community as a farmer, and of broad repute as an intelligent friend of agriculture, the late Henry T. Rainey, veteran member of the House of Representatives and at his death its speaker, has never, to our knowledge, been accounted an engineer. Yet one of his last official acts was to crystallize, with classic brevity, one of the doctrines of engineering. It was in no abstract discussion, no moot case, but in an actual case of an industry crying for its life and employment in the balance.

As legate to Washington from his district, Speaker Rainey was pleading for a small stone crushing plant at Eldred, Illinois, seeking exemption from the wage requirement of its governing code, namely, a minimum of forty cents an hour. Operating on a hand-labor basis, it was paying 20 to 25 cents and claimed that at forty cents it would be forced out of business, because, in the Speaker's words: "Hand-operated plants absolutely cannot compete with nearby machine-operated plants and pay the same wages."

Coming on the heels of the A.S.A.E. annual meeting, this is striking support of President Huntington's statement in his address that: "Low wages and child labor are not the result of avarice; they are both a forlorn effort of poorly equipped plants to compete with those having better equipment."

Assuming the figures to reflect a competitive balance, they mean that after bearing all the costs of machinery, a man with its aid can earn twice as much; or that after all deductions for labor embodied in the machine and its maintenance, he still can produce twice as much crushed stone as he could without the machine. If we think in terms of social well-being and materials for living standards, it means doubling the workman's contribution to society. If we think in terms of industrial volume and employment, it means reductions in cost of product which open up new and larger markets, with attendant profits and employment. In the case of agricultural limestone, at least, there is a tremendous market held back only by the element of cost.

In the political field it was observed that Mr. Rainey was at the peak of his powers and statesmanship when his final illness overtook him. It is to be hoped that his laconic utterance on the economic and social effect of machinery will be held in the hearts of his surviving colleagues in the realm of governmental guidance.

Engineers as Executives

DESIGNATION recently of E. A. Johnston, director of engineering for the International Harvester Company, as one of the company's vice-presidents is a landmark in the progress of agricultural engineering. It is not the beginning, but rather the culmination of a steady trend toward engineering talent in executive positions. Among smaller companies serving agriculture, a number of outstanding rank have long been staffed at the top by engineers. For some time, though more recently, the second and third largest companies in the farm equipment industry have had prominent agricultural engineers as vice-presidents or as directors. It also happens that each of these companies has for its president a man so concerned with engineering as to be a member of A.S.A.E.

We feel sure that placement of an engineer in the directorate of the world's largest farm machinery company did not result from any policy, but is simply incidental to Mr. Johnston's demonstrated capacity as a counsellor in company policy. Yet it reflects the increasing importance of engineering in the affairs of big business, and emphasises the value of the engineering type of mind for executive responsibility.

In his long service in the farm machinery industry Mr. Johnston's contributions to the subject matter and methods of our profession are too many and too varied for specific mention here. Indeed, he has been so much an executive in engineering that it is but a step to his present position. In achieving it he does honor to himself, his company, and his profession.

Land Utilization—a Technical Problem

TO THOSE present at the symposium on land utilization, held at the A.S.A.E. annual meeting at Detroit in June and largely published in these pages, it may seem incredible that land utilization is, in some hazily-informed quarters, under suspicion as being a phase of a "planned economy" having possibly sinister implications. Of course, any planned economy deserving the name would surely include at least a degree of control in land usage. To assume the converse, that any efforts toward more efficient and intelligent use of land are a committment to a changed economy, would not be deemed sound logic by engineers.

As the subject has been discussed among agricultural engineers, there need be no conflict between the apostles of planned economy and the defenders of rugged individualism. The objectives are much the same from either viewpoint. Presumably both views will agree that it is well to have a thought for posterity. The protagonists of private property rights can hardly object to measures aimed to preserve permanently the value of land as property. In the case of land whose property value is doomed to extinction for agricultural uses, they should welcome measures that will salvage its value, at least in part, by conversion to other uses with social values and remuneration of existing owners.

Still more obvious is the protection of other property

from damage by ill-advised use of land. That great cities should suffer millions in flood damage through unwarranted removal of forest or grass cover from lands dozens or hundreds of miles away is an affront to the sanctity of private property, obvious in principle even if the relations of cause and effect may be obscure to the non-technical mind. Indeed, it is only because the causes of floods, silt damage, and perhaps drought, are but dimly sensed by the lay mind that we do not have spontaneous popular demand for such control of land utilization as will abate these destroyers of property, whether farm lands or urban improvements.

The physical laws of flowing water, soil properties, evaporation, transpiration, etc., and the relations of crops to soil and climate take no heed to man-made economics, and will assert themselves immutably without regard to the social order. It is to these stubborn material facts that the agricultural engineer, and with him the agronomist, husbandman, etc., address themselves. No meddling with the social order can convert a gully or a flood into an economic asset; neither can efforts to solve such technical problems as these be sanely construed as tampering with the human aspects of economic or political structure.

NEWS

C.R.E.A.'s Eleventh Birthday

RECEIPT at A.S.A.E. headquarters office of the eleventh annual report by the director of the Committee on the Relation of Electricity to Agriculture calls for more of comment than routine review. Be it noted in passing that the director, Dr. E. A. White, has the distinction of being the youngest charter member of the A.S.A.E. It so happened that he represented the University of Illinois at the founding meeting while still an undergraduate.

Once more the amazing vitality of farm electricity is shown. Again there is a net increase in the number of farms served. The increase during 1933 was 4,109, several times the gain during the low-ebb year of 1932, which in turn was something of a miracle in contrast to the general shrinkage which then prevailed. Still more heartening is the showing for the first five months of 1934, when the increase amounted to 10,809 farms—two and one-half times as much as the whole of 1933.

Separating the states into two groups by approximately the 100th meridian of longitude, Dr. White found that the east division could account for all and more of the 1933 increase in farms served, for in the west division there was a slight decrease (one-fifth of one per cent). This division is significant in that in the West irrigation pumping is a major load factor, while in the East it is negligible, representing two distinct lines of agricultural engineering development. Quoting Dr. White:

". . . . we find farmers in regions where irrigation is generally practiced buying 7.8 times as much energy for just a little over twice the annual bill as the farmers in other regions. This again demonstrates that the road to extremely low-priced electricity for our rural districts lies in a much larger use. We must plan to do many more things electrically. Volume must flow over this great network of distribution lines which is gradually being extended farther and farther into the country. I have no hesitation in saying that ways and means to attain this end constitute the primary problem facing this committee. It is far more important than further extension of lines."

Agricultural engineers may flatter themselves that, as Dr. White said a few years ago, they have created the type and volume of electric load which has made farm service economic for the power companies and at the same time economical for the farmer. With due credit to the electric lights, ranges, refrigerators, etc., which the farm has borrowed from the town, it is electric brooding, soil heating, silo filling, feed grinding, etc., not to mention irrigation, which have so improved load and diversity factors as to permit low rates. (In the western division the 1933 average revenue per kilowatt-hour was 1.73 cents.)

The relation of agricultural engineering to farm electricity is reflected from another angle. Dr. White points out that only ten states, containing less than 30 per cent of the nation's farms, have more than 58 per cent of the electrified farms. To correlate this with A.S.A.E. membership we have made a count of members in the continental United States, excluding the District of Columbia because its members represent national rather local activity. The same ten states which have 58 per cent of the electrified farms have 57.27 per cent of A.S.A.E. members.

These figures of themselves are only a striking coincidence, not proved casual relation. From other sources we know that agricultural engineers in these states have worked on farm electricity to an extent that indicates fair correlation. As well as we can judge, the correlation is not so much with number of members specializing in rural electrification as with the total membership in all branches of the profession.

If we dare draw a conclusion, it is that a fully rounded engineering of agriculture creates a better market for electricity than does emphasis directly on electrification alone.

Among his recommendations Dr. White sounds a warning. Of late economic conditions have curtailed fundamental research in agricultural electricity and in applicational studies under private sponsorship. Public agencies have diverted much of their activity from research and development to surveys. Unavoidable and desirable, respectively, as these may be temporarily, he urges that creative development must be resumed if the forward march of farm electrification is to be maintained. In that judgment we believe that the organized profession of agricultural engineering will concur, and to that purpose lend its support.

North Atlantic Section Meeting

THE North Atlantic Section of the American Society of Agricultural Engineers will meet at Massachusetts State College at Amherst, October 17, 18, and 19. As this issue of AGRICULTURAL ENGINEERING goes to press, the program has not been released, but it is safe to promise that it will be up to the usual high standard of this section. The Section always presents an excellent program. An intensely interesting group of subjects is being arranged for discussion, which will be presented by a strong list of speakers.

These are times of great basic changes in the making, which will affect agricultural engineers as much as other groups. It therefore behooves every agricultural engineer to be constantly alert and abreast of developments in his field. Attendance at the North Atlantic Section meeting at Amherst affords a most excellent opportunity to keep in touch with members of the profession and what is going on in this field.

New ASAE Members

Ralph C. Hay, assistant in research and teaching, department of agricultural engineering, University of Illinois, Urbana, Ill. (Transfer of grade)

Joseph A. Payette, field engineer, U. S. Tire Company, Inc., 6600 E. Jefferson Ave., Detroit, Mich.

Claude H. Van Vlack, associate professor of agricultural engineering, Iowa State College, Ames, Iowa.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Robert Lamar Green, assistant agricultural engineer, Soil Erosion Service, U. S. Department of the Interior. (Mail) 370 S. Lumpkin, Athens, Ga.

J. C. Oglesbee, Jr., district farm supervisor, Rural Rehabilitation Division, Richmond County E.R.A., 708 Telfair St., Augusta, Ga.

Norman L. Palmer, assistant agricultural engineer, Soil Erosion Service, U. S. Department of the Interior. (Mail) Box 71, Meridian, Miss.

F. W. Peikert, assistant professor, department of agricultural engineering, University of Georgia, Athens, Ga.

Harold J. Shold, senior erosion engineer, State of Iowa Emergency Conservation Work. (Mail) Solon, Iowa.

STUDENT ACTIVITIES

Contributed and edited by A.S.A.E. student members

Looking to Closer Contacts Between Students and Society

By Lester Malkerson (Minn. '35)

President, Agricultural Engineering Students' Conference

"WHY should I be a member of a student branch of the A.S.A.E.?" is probably the first retort of a person when the question of becoming a student member is suggested to him.

When I consider this question of why a student should affiliate himself with the A.S.A.E., I can see several very good reasons for doing so. One is the opportunity such affiliation affords for contacts with members of the Society. From a student's viewpoint, this is a very important reason. It is from these contacts that we, as students, hope to acquaint ourselves with men who have the experience that we do not have. We wish to profit by the experiences of others, and one way to do this is to get acquainted with the older members of the Society.

Last June at the annual meeting at Detroit, it was decided that the Committee on Student Branches of the Society should consist partly of men from the colleges and partly of commercial men. This seems to be a good idea, and I believe it could be carried still further by having the student advisors of each branch composed of one educational and one professional man.

Many students now studying agricultural engineering desire to work into the commercial field. These students would be benefitted by contacts with the professional men, in that they could learn what is expected of prospective employees. The student could then correlate his studies with the suggestions received, and in this way be benefitted.

It has been said that men are picked for jobs and that the men do not pick their jobs. With this in mind, it seems that it would be advisable to become acquainted with as many men as possible. One way to bring this about is to invite the professional men to the student branch meetings as guests and as speakers. By doing this, I am quite sure that interest in the student branch meetings will be aroused, and the students will come to the meetings because of the opportunity to meet these men. It may sound mercenary, but I know in my own case I would be much more likely to go to a meeting that was to be attended by some person whom I had not previously met, than if no such men were to be present.

By bringing in the professional men I believe the student branches will be benefitted. The present members will be benefitted, and it will induce more students to become members. The Society will be benefitted also, since a stronger bond with the students will be created through the friendships and acquaintances brought about by introducing the professional men to the student branches of the Society.

A Message to A.S.A.E. Student Branches

By Chas. Schlotterbeck (Ohio)

Vice-President, Agricultural Engineering Students' Conference

HOW would you like to take a trip over the entire United States, visiting every student branch of the American Society of Agricultural Engineers in the country? We think this can be arranged, and with very little cost to any student member who cares to go. There is only one thing wanting in our plans to make them complete. Before we stop at any one of the student branches, we must first have from them an invitation to be their guests. That is the purpose of this request.

At the 28th annual meeting of the A.S.A.E. held at Detroit last June, the student group—that is, the Agricultural Engineering Students Conference—asked if it might have a little space in AGRICULTURAL ENGINEERING. This request was granted, so every month this year you'll find one or two pages of student news in the "Journal."

This news is to be composed entirely of the activities of the various student branches of the Society over the country. If you have wondered what other branches are doing and how they do it, just join the gang and enjoy visiting each and every agricultural engineering department in the country. The only obligation on your part is to make sure that your student branch is accepting and welcoming us as your guests. All that is asked of your branch is that it furnishes its share of the news. If you are doing, or have done, anything you think worth while, let the rest of us know about it. Please address all news to Charles Schlotterbeck, Agricultural Engineering Department, Ohio State University, Columbus, Ohio, who will edit it and forward it to Society headquarters for publication.

This is a picture of the A.S.A.E. student members in attendance at the Society's annual meeting at Detroit last June. First row (left to right): Lester Malkerson (Minn.), Chas. Schlotterbeck (Ohio), J. B. Stere (Penn.), and W. D. Scoates (Tex.). (These men, in the order named, are president, vice-president, secretary, and treasurer of the Agricultural Engineering Students' Conference for 1934-35.) Second row (left to right): Izadore Lasensky (Ames), H. A. Collin Jr. (Oregon), A. W. Carpenter (Minn.), Edward Bonner, Jr. (Penn.), John Control (Ames), Merritt Mouson (Ohio), Edwin Jezek (Ames). Third row (left to right): Wayne Shober (Ohio), C. B. Richey (Ames), K. B. Huff (Mo.), G. W. Gilles (Mo.), M. E. Strickler (Penn.), Shafor Meeks (Penn.). Four other student members attending the meeting, but not in the picture, were Orvis Myers (Penn.), L. E. Nelson (Minn.), W. C. Gillham (Ill.), and R. V. Winters (Ill.)

A Word from the Editor

WHEN the printer made up this page, there was not quite enough material to fill, so this gave the editor an excuse to "put in his five cents."

Soon after this issue is in the mails, hundreds of ag engineers in the making will be registering for another college year, and what I want to urge especially is that student branches of the Society be organized just as early as possible this fall.—Editor.

Agricultural Engineering Digest

(Continued from page 335)

excess of 20 per cent. If sufficient bin space is not available for storing the rice between drying operations, or if for other reasons it is necessary to dry the rice in one operation, the drying-air temperature should not exceed 110 deg for best results.

Artificially dried rice should remain in storage for a few days before it is milled or sampled for official grading. Rice harvested with a combine should usually be cleaned before drying. Small lots of rice should be consolidated whenever possible, as bin space, fuel, and labor can be conserved in drying large lots and in keeping the drier in continuous operation.

Commercial driers will usually do the work for which they are designed without changes or alterations on the part of the operator.' Under ordinary conditions no attempt should be made to increase the quantity of air supplied by a fan as the increase in the power requirements may offset any gain in rate of drying. In some driers, however, the rice may funnel, causing uneven drying. This trouble can usually be rectified on some driers by changing the position of supporting members for the shut-off valves between the drier and cooler and between the cooler and discharge hopper.

THE BARRIER SYSTEM FOR CONTROL OF FLOODS IN MOUNTAIN STREAMS, *L. M. Winsor.* U. S. Dept. Agr., Misc. Pub. 165 (1933), pp. 24, figs. 12. This publication presents the results of 10 years of experiments conducted in cooperation with the Utah Experiment Station relating to the development of the barrier system of flood control.

It was found impracticable to construct channels which will carry away the debris brought down by torrential floods in mountain streams or the gravel flows that follow. It appears that any such channel will fill rapidly with detritus and overflow at the point where the grade changes from heavy to light.

The barrier system of flood and gravel control developed appears to have a broad range of application. The principles evolved are based upon natural laws and may be used wherever floods carry a heavy load of debris.

The success of the barrier system is dependent upon the amount of reasonably smooth surface over which the flood stream may spread before it reaches the stilling pool above the barrier. The lateral embankments merely define the limits of the depository. The wider they are apart the less the height needed to give protection against flood damage. If the flood is permitted to spread laterally over a broad surface there is less danger that the pool above the barrier will be filled with debris. The tendency of the successful barrier is toward complete unloading of the flood stream on the surface of the cone above the barrier where the lateral embankments are widely separated. Where the unloading process is complete the fine sand and silt are dropped in the stilling pool. The natural channel will usually carry the water after the heavy detritus has been dropped.

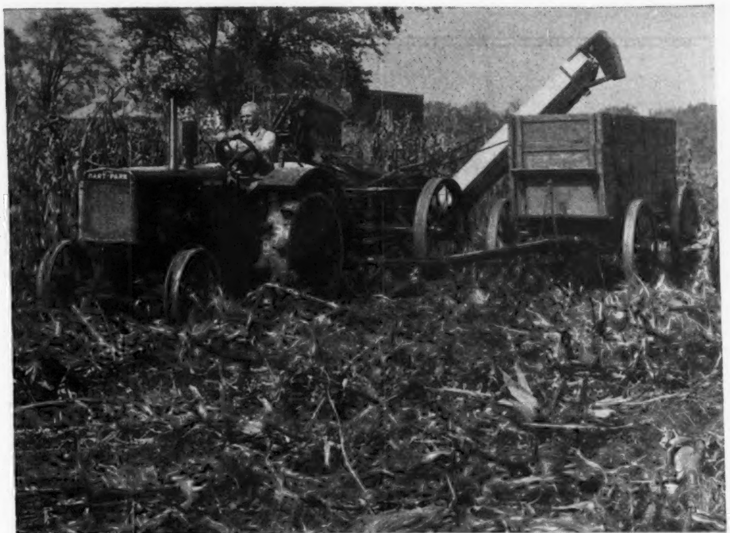
An outstanding feature in the barrier system is the method by which a stream carrying a capacity load of sand, gravel, boulders, and mud may be used in building the lateral embankments and the barrier of a control basin where a natural site does not exist. The method may be used to build marginal embankments for control works at any section of an alluvial cone, even though the surface of the cone is higher than the natural ground on either side. This principle may be used also under some conditions in building levees along streams that overflow their banks because of the debris they transport to lower levels.

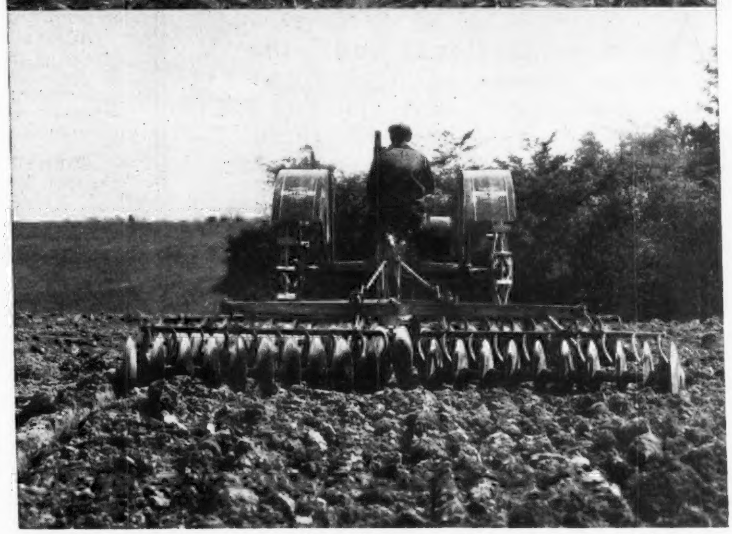
Literature Received

MONEL METAL AND NICKEL: APPLICATION TO INDUSTRIAL PROCESSING EQUIPMENT. International Nickel Company, Inc., 67 Wall Street, New York City. Prepared distinctly in the technical handbook manner and punched for insertion in pocket size covers. Lists the many forms in which these metals and their variants, including nickel-clad steel, are available; their mechanical properties, physical constants, and technologic properties; chemical properties as regards resistance to corrosion stated in decimals of an inch per year, for classes and mixtures of substances, and at pertinent temperatures. Welding rods and fluxes for both gas and electric welding are specified, and Ni-Resist, a machineable, nonmagnetic, heat and corrosion-resisting cast iron, is mentioned. Contra-indications and cautions, as well as adaptations, are considered. Much of the space is given to a tabulation of established uses, arranged alphabetically according to materials handled, stating the industries or processes involved, with specific applications named for each of the metals. Numerous notes refer to other publications or suggest special inquiry when expedient. Though broadly industrial in scope, sundry mention of behavior in contact with foods and agricultural materials is included. Supplied gratis on request.

Hard Knocks Mean Nothing To

NICKEL





TOP: *Oliver Hart-Parr tractor pulling Oliver corn picker and husker. Husker snapping rolls are made of Nickel-chromium steel by Joseph T. Ryerson & Sons, Chicago.*
BOTTOM: *Disc harrow also made by Oliver Farm Equipment Company, Chicago.*

● WHEN the farmer buys
Your implements
You know he'll
Treat 'em rough

So the tougher
You make them
The less money
He spends for upkeep

Machinery that
Can take hard knocks
Not only saves money
On upkeep
But it never puts
The farmer in the hole
When he has to make
The best of the weather

Leading manufacturers
Find that it's no longer
Costly nor difficult
To give equipment this
Added endurance
And dependability

They find the answer
In alloys
Containing Nickel

For highly stressed gears,
Shafts, bolts, and
Dozens of other
Vital parts
They use Nickel Alloy Steels

For engine blocks
Liners, brake drums
And all parts requiring
Unusual resistance to
Pressure, heat and wear
They use Nickel Cast Irons

The Nickel content
Makes these materials
Remarkably tough and strong
And increases
Resistance to impact,
Stress, shock, abrasion
Corrosion and wear

Before you put
New designs
Into production
Consult our engineers
They will be glad
To tell you how
The alloys containing Nickel
Can appreciably extend
Their service life

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK, N. Y.
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EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested.

Men Available

AGRICULTURAL ENGINEER with both bachelor and master of science degrees (majoring in agricultural engineering) from midwest universities, two summers' experience as irrigation investigation engineer in midwest state, experience in soil erosion work, and five years' experience with agricultural engineering department of large university where the duties consisted of research work in reclamation, farm development, land use study, and a regular teaching schedule mainly in reclamation, desires employment where qualifications meet the need, preferably with farm equipment company, in federal work, or in agricultural engineering with some state agricultural college. Married. Age 27. MA249

AGRICULTURAL ENGINEER, graduating this June as a member of the first agricultural engineering class from University of Illinois, with twelve years' experience as draftsman, tool and jig designer, designer of automatic machinery, and foreman of mechanical research and development department. Prefers to locate in the Southwest. Available July 1. Age 40, married. MA-251

AGRICULTURAL ENGINEER, with bachelor of science degree from Montana State College, and master's degree from Iowa State College with major in vocational education and minor in agricultural engineering, who for the past four years has been working on an advanced degree in agricultural engineering on a part time basis; who is a qualified Smith-Hughes vocational agriculture instructor; who has had eleven years' teaching experience, including five years as instructor in farm mechanics in agricultural engineering department of Iowa State College, and who has served as supervisor of practice teaching in farm mechanics for the vocational education department of I.S.C. for the past three years, desires position as instructor in agricultural engineering in some state agricultural college. Married. Age 36. MA-252

RURAL ELECTRIFICATION ENGINEER with bachelor's degree from an eastern state college (1928) now employed by one of the largest public utilities in the East, desires a change of location. He is experienced in all farm operations, thoroughly understands rural problems, has had six years' experience in rural electrification, and has also taken the rural electrification course offered by General Electric Company. He would be interested preferably as rural electrification engineer with a public utility, in experiment station research work, with an equipment manufacturing concern, or as a graduate assistant. Age 29. Single. Will go anywhere. MA-253

AGRICULTURAL ENGINEER desires employment in soil erosion control work, soils, drainage, or any other phase of land reclamation. He is a 1915 graduate in forestry of the University of Washington; has had extensive experience in land clearing, drainage, and heavy construction work; has made an intensive study of soils, drainage, etc., and for the past ten years has been engaged in private professional practice as a civil and landscape engineer, and is a registered civil engineer and land surveyor in the states of New Jersey and New York. Age 40. Married. Prefers location in the East, but will go anywhere. MA-254

AGRICULTURAL ENGINEER, graduate of a midwest university, with several years' experience teaching farm mechanics in state agricultural college and with wide experience in testing, extension, research, and editorial work, desires position in state agricultural college or federal work, or with commercial firm where his training and experience can be capitalized. MA-255

Position Open

ENGINEER wanted. Must have experience in design, development, and experimental work relating to farm machinery, preferably tillage. Must be 35 to 40 years of age, have experience in handling men, and ability to cooperate with production departments. Graduate engineer desired, but not necessary. In replying, give age, education, experience in detail, salaries received and expected. PO-101